

# Presence of Automated External Defibrillators in North Carolina Public Middle Schools

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**BACKGROUND** Automated external defibrillators (AEDs) have been used in the school setting to successfully resuscitate students, staff, and visitors. All public high schools in North Carolina have an AED. However, the number of North Carolina public middle schools with an AED is unknown.

**OBJECTIVE** The purpose of this study was to determine the presence of AEDs at public middle schools in North Carolina and to estimate the cost associated with providing an AED to all public middle schools currently without one.

**METHODS** All 547 middle schools in North Carolina's 117 public school systems were surveyed in 2009 via e-mail, fax, and, when necessary, telephone about whether an AED was present on site. For middle schools without AEDs, we estimated the cost of purchase and for 1 year of maintenance.

**RESULTS** A total 66.6% of public middle schools responded to 1 of 3 survey mailings. The remaining schools were contacted by telephone, so that 100% were included in data collection. At the time of the survey, at least 1 AED was present in 334 schools (61.1%). Of the 213 schools without AEDs, 57 (26.8%) were in school systems in which some middle schools had AEDs, and 156 (73.2%) were in systems in which no middle school had an AED. On the basis of a start-up cost of \$1,200 per AED, the cost of providing an AED to each school without one is approximately \$255,600.

**LIMITATIONS** These data are based on self-report, and we could not verify whether AEDs were functional. Cost estimates do not include charges for ongoing maintenance and staff training.

**CONCLUSIONS** Two hundred and thirteen North Carolina public middle schools (38.9%) do not have an AED on site.

Several major medical organizations have recommended the placement of automated external defibrillators (AEDs) in major public gathering places, including all health and fitness clubs [1, 2]. The American Heart Association, the American Academy of Pediatrics, the American College of Emergency Physicians, the American Red Cross, and several other medical, nursing, emergency medical, and public health organizations endorse guidelines for treating cardiac arrest in schools where the presence of an AED is recommended. However, these recommendations propose having an AED in a school only if at least one of the following criteria is met: there is a reasonable probability of AED use within 5 years after AED placement and training of lay rescuers, there are children attending and/or adults working at the school who are at high risk for sudden cardiac arrest, or an emergency medical services call-to-shock interval of less than 5 minutes cannot be reliably achieved [3]. The American Medical Association has also adopted a resolution pledging its support to state legislation and educational policies, encouraging each high school and college that has an athletic program to have an AED and appropriately trained personnel, and encouraging high school athletic coaches, sports medicine personnel, and student athletes to be trained and certified in cardiopulmonary resuscitation (CPR) and AED use [4]. Currently, no organizations have guidelines that address AED placement in middle schools.

Lives saved with AEDs at airports [5] suggest that inexperienced individuals can successfully use the devices, since

untrained samaritans performed over half of AED resuscitations. Public schools often function as the site of school-sponsored activities, including athletic events, celebrations, and meetings (such as those involving the Parent Teachers Association), and non-school-sponsored activities, including community events (such as voting). Numerous successful cardiac resuscitations of spectators, students, and athletes by use of AEDs at athletic events and functions held at high schools and colleges have been documented [6-9], and there are anecdotal reports of resuscitations of students from middles and elementary schools.

Without a mandatory reporting system, historical estimates probably underestimate the prevalence of sudden cardiac arrest (SCA) and sudden cardiac death among children and young adults. In Minnesota, a statewide survey suggested an annual incidence of approximately 1 SCA per 200,000 young athletes [10]. The estimated annual incidence of SCA for students in Seattle and King County, Washington, is 0.18 cases per 100,000 students [11]. A more-recently published study suggests that 5.05 SCAs per 100,000 person-years occur outside of hospitals among

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children and adolescents, which is approximately equivalent to 1 case per 20,000 children and young adults [12]. Before the implementation of a national screening program, the registry for the Veneto region of Italy displayed a ratio of 1 sudden cardiac death per 28,000 young athletes [13].

Because of the recommendations to place AEDs in public gathering places such as schools and the recent epidemiologic data on SCA and sudden cardiac death among youths, we sought to document the current availability of AEDs in North Carolina public middle schools and to use this information to estimate the cost of placing an AED in each middle school that lacks the device.

## Methods

In the summer of 2009, all 117 public school systems in North Carolina were surveyed regarding the presence of AEDs in their middle schools or schools housing middle-school-aged children (ages, 11-14 years) (Figure 1). Responses were recorded in a database containing the name of each school system, the names of the middle schools in each system, the name and title of the superintendents at each school, the AED status at each school, and the name and contact information of personnel at a central office or specific middle school who provided the appropriate information. The study was determined to be exempt from review by the institutional review board at Moses Cone Hospital. All respondents were aware of our intention to publicize survey data.

Initially, every superintendent of a North Carolina public school system was asked on June 16, 2009, via e-mail to fill out an online survey or complete and fax a paper survey. A total of 41 school systems responded within 2 weeks after this initial correspondence was sent. The remaining 76

school systems were contacted a second time via e-mail, on July 2, 2009, approximately 4 weeks after the initial attempt. This second attempt yielded responses from 22 additional school systems (total responses to this point, 63 school systems).

The remaining 54 school systems were contacted a third time via e-mail, on August 10, 2010, approximately 8 weeks after the initial attempt. The third attempt yielded responses from 15 additional school systems, bringing the total number of surveyed school systems to 78. The remaining 39 school systems were contacted on a school-by-school basis via a telephone conversation with a principal, assistant principal, or school nurse to determine the presence or absence of an AED at the school. Ultimately, AED status was obtained for all 547 middle schools in these school systems.

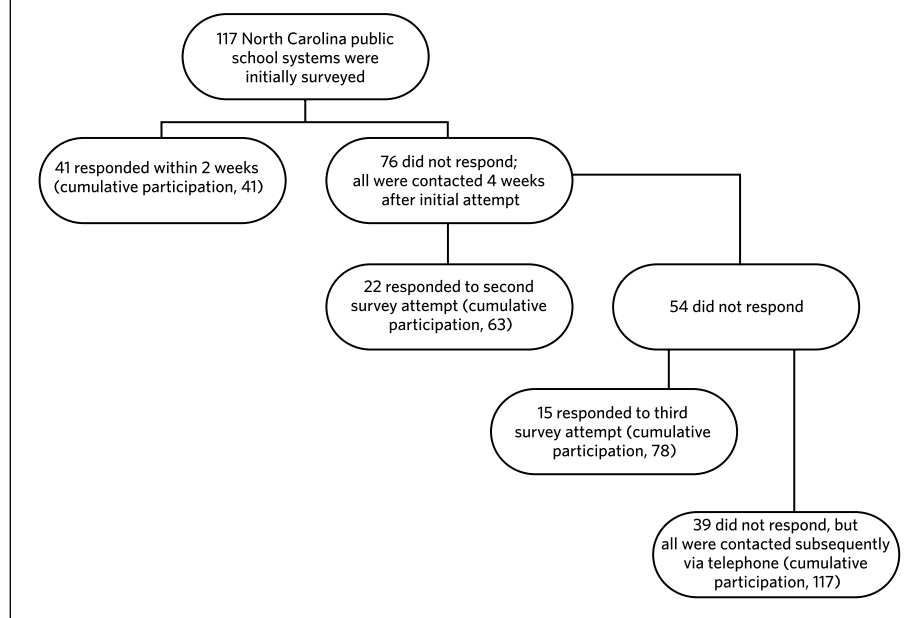
Cost data for AED placement and maintenance for the first year of operation were obtained by contacting 6 vendors who supply AEDs throughout North Carolina.

## Results

The North Carolina Public School System covers 100 counties with 117 school systems, each of which has at least 1 middle school. Figure 2 shows AED presence by county and demonstrates no clear pattern associated with urban or rural counties.

Sixty-three school systems (53.9%) had an AED in all middle schools, and 39 (33.3%) had an AED in no middle schools (Table 1). A total of 334 public middle schools (61.1%) had an AED, of which 57 were in a school system in which some schools had an AED. Of the 213 middle schools (38.9%) with no AED, 57 were in a school system in which some schools had an AED.

**FIGURE 1.**  
Survey Contact Methods and Responses



**FIGURE 2.**  
North Carolina Public Middle Schools With an Automatic External Defibrillator (AED) on Site



Note. Chowan, Perquimans, and Pasquotank counties in northeastern North Carolina are denoted by 1, 2, and 3, respectively.

Costs for 6 different AEDs ranged from \$1,095 to \$1,595, including maintenance for the first year of operation. The warranty duration for 4 of the units was 5 years, with 2 having a 7-year term. Batteries for these units, which are the most expensive parts to replace, are guaranteed for an average of 4 years.

## Discussion

This study found that 38.9% of North Carolina public middle schools lacked an AED. Geographic mapping did not demonstrate a clear pattern by region or by urban versus rural status that explains AED placement. While the majority (53.9%) of school systems had AEDs in all middle schools, some systems (12.8%) had them only in some schools, and many (33.3%) had them in no schools.

Several states have passed legislation mandating that an AED be present and properly maintained in public schools [14]. Florida and Georgia currently require an AED and appropriately trained personnel in all public high schools with athletic programs. Maryland, Ohio, and South Carolina require every school in the state to have an AED on the premises and at all school-sponsored athletic events. Nevada and New York require an AED in schools that meet certain population requirements, whereas Tennessee requires an AED in all schools "within current budgetary limits" [14].

The argument against AED placement in public schools is based on the assertion that the initial purchase places a financial burden on the school and/or school system. This initial cost has deterred many states and school systems from mandating that every school has at least 1 properly functioning AED [15, 16]. We contacted 6 AED vendors and found that the median cost of purchasing 1 AED and training a lay person to use it is \$1,200 (range, \$1,095-\$1,595). On the basis of these data, it would cost \$255,600 ( $[213 \text{ schools}] \times [\$1,200 \text{ per AED}]$ ) to provide an AED to all public middle schools and schools housing middle-school-aged students in North Carolina.

Of note, the startup cost of \$1,200 per AED includes training and, for AEDs purchased through state-controlled agencies, initial quality checks. The price of the AED alone, without training, is estimated to be \$1,000. Many school systems coordinate with local emergency medical services and or hospital emergency services to provide ongoing training and monitoring of schools' AED readiness and emergency action plans (Karen Dehart, North Carolina High School Athletic Association, written communication, January 13, 2009). The start-up cost data do not reflect the ongoing expenses associated with replacing pads and batteries and providing service to the AEDs after the initial year of placement.

Resuscitation data suggests that AEDs are effective in school settings and that the presence of an AED leads to a higher survival proportion among individuals who experience SCA. Between December 2006 and November 2007, 13 (65%) of 20 high school athletes who had SCA while participating in athletic competitions were successfully resuscitated at the scene of the SCA, of whom 11 survived and were discharged from the hospital. This accounts for a 55% survival proportion associated with use of defibrillation following SCA among school-aged children [6].

Children and adolescents who experience SCA typically have no history of cardiac illness. Statistically, the percentage of patients who survive SCA and are discharged from the hospital gets significantly lower for those who do not immediately receive CPR and defibrillation shortly after an incident [3]. The chance of surviving SCA decreases by 7%-10% for every minute defibrillation is delayed; immediate CPR following SCA results in survival proportions only decreasing by 3%-4% per minute [17, 18]. The problem of rapid access to care for individuals who experience SCA is compounded in rural North Carolina counties where health care providers are limited, and the distance between a school and the nearest clinic or hospital may exceed 30 miles. The federal government acknowledged the delays in emergency

**TABLE 1.**  
**Presence of Automated External Defibrillators (AEDs) in North Carolina Public School Systems**

| AED presence        | School systems, no. (%) (N = 117) | Middle schools in school system, no. (%) (N = 547) |
|---------------------|-----------------------------------|----------------------------------------------------|
| All middle schools  | 63 (53.9)                         | 277 (51.0)                                         |
| Some middle schools | 15 (12.8)                         | 114 (20.8)                                         |
| No middle schools   | 39 (33.3)                         | 156 (28.2)                                         |

Note. A total of 213 middle schools (38.9%) had no AED, of which 57 were in school districts in which some middle schools had an AED.

response in states with rural populations by passing the Rural AED Act as a part of the Public Health Improvement Act [19].

Recent studies suggest that SCA among adolescents is much more common than previously estimated. The only prospective data that includes urban, suburban, and rural settings was reported by the Resuscitation Outcomes Consortium, which studied 11 US and Canadian communities serving 23.7 million people. The consortium reported an incidence of pediatric SCA to be 8.04 cases per 100,000 person-years during a 15-month period (December 2005–March 2007) [12]. If data for infants are excluded and data for children (3.73 cases per 100,000 person-years) and adolescents (6.37 cases per 100,000 person-years) are averaged, the rate of pediatric SCA is 5.05 annual cases per 100,000 person-years. While the number of SCAs that occur outside of school settings would not be affected by the AED placement in the schools, the overall higher frequency of SCA among children and adolescents, as well as the improved survival rates among resuscitated individuals, suggest that AED placement in middle schools has a potential survival benefit [12].

Without stronger data delineating the risk of SCAs that occur in school settings, as opposed to nonschool settings, we cannot confidently calculate the costs, in terms of the number of student lives saved, associated with placing AEDs in middle schools. However, the overall number of lives saved by placing AEDs in middle schools would be expected to be higher than the number based solely on the student population, as adults in a school setting have a 25-fold greater risk [11] of sudden cardiac arrest than students.

For AEDs to be effective in schools, several additional steps must be taken by school systems, including (1) creating an emergency action plan that stresses early CPR and defibrillation [15]; (2) creating a team of individuals within the school system who know the emergency action plan and are trained in CPR and AED use; (3) providing CPR training as part of the high school health curriculum; (4) ensuring that AEDs are present at school public gatherings, including sporting events; and (5) performing geographic mapping of campuses to ensure that an AED can be accessed in less than 5 minutes from any location on campus. On the basis of information from earlier studies, this type of coordinated

emergency action plan is lacking in many schools, which limits the effectiveness of AEDs in these settings [15].

Research shows that AEDs are effective in that high rates of survival and discharge from the hospital among students who experience SCA cannot be achieved without quick defibrillation. Properly equipping every public middle school in North Carolina with an AED and training an appropriate number of personnel to effectively use the equipment have the potential to create a safer environment in North Carolina public middle schools for all students, faculty, staff, and visitors. NCMJ

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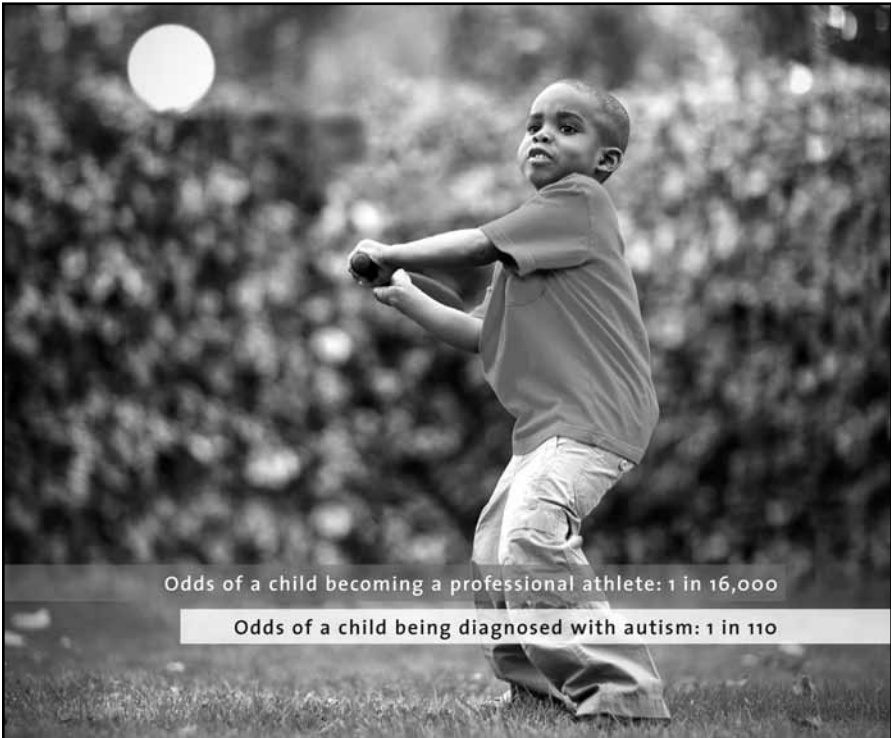
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Odds of a child becoming a professional athlete: 1 in 16,000

Odds of a child being diagnosed with autism: 1 in 110

**Some signs to look for:**

|                                                        |                           |                        |
|--------------------------------------------------------|---------------------------|------------------------|
| No big smiles or other joyful expressions by 6 months. | No babbling by 12 months. | No words by 16 months. |
|--------------------------------------------------------|---------------------------|------------------------|

To learn more of the signs of autism, visit [autismspeaks.org](http://autismspeaks.org)

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