

**Relationship Between AED Allocation as well as
Students' Awareness and Schools' Characteristics
in Shanghai**

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Abstract

My research focuses on the relationship between AED allocation, students' awareness, and the software/hardware characteristics of primary and secondary schools in Shanghai. During data collection, I utilized a self-designed questionnaire and gathered 40 responses from students and teachers. Subsequently, I conducted a linear regression analysis using the R programming language to derive answers to the research questions. The results indicate that among all the potential factors I hypothesized, only school size significantly affects the number of AEDs allocated, while only the student-teacher ratio significantly influences students' awareness of AEDs. Thus, we concluded that schools without AEDs can use campus size as a determining factor for whether to install AEDs and how many units to deploy.

Keywords:

Automated External Defibrillator (AED), cardiopulmonary resuscitation (CPR), sudden cardiac arrest (SCA), public access defibrillation (PAD), emergency medical services (EMS), cardiac arrhythmia, defibrillation, resuscitation, first aid, survival rate

1. Introduction

Sudden cardiac arrest (SCA) is a critical public health issue and a leading cause of death worldwide (Douglas P. Zipes, 1998). The chances of survival decrease by 7–10% with every minute that passes without defibrillation, making immediate access to automated external defibrillators (AEDs) a key factor in improving outcomes.

Schools, as high-traffic environments where students, staff, and visitors spend significant time, are important locations for AED deployment. However, despite their life-saving potential, AED availability in schools varies widely, and many students lack the knowledge to use them effectively in emergencies.

Existing research has demonstrated that AEDs significantly improve survival rates when used promptly, particularly in public settings (RA Winkle, 2010). However, studies focusing on schools have primarily examined AED placement policies rather than the interplay between device accessibility, student awareness, and institutional characteristics. Factors such as school size, location (urban vs. rural), funding type (public vs. private), and prior training initiatives may influence both the presence of AEDs and the level of student preparedness. Yet, little is known about how these variables interact to shape emergency response readiness in educational institutions.

This study seeks to bridge this gap by analyzing the relationship between AED availability, student knowledge of AED usage, and school-specific factors. By collecting and evaluating data from multiple schools, we aim to identify patterns that could inform better AED deployment strategies and educational interventions.

Understanding these dynamics is crucial for policymakers and school administrators to optimize resource allocation and training programs. Given that schools serve as community hubs, improving AED accessibility and awareness in these settings could

have far-reaching benefits, not only for students and staff but also for the general public during after-hours events. Ultimately, this research contributes to broader efforts to enhance cardiac emergency preparedness and reduce preventable deaths.

2. Literature Review

2.1

Recent studies reveal a troubling disconnect between theoretical awareness and practical competency in CPR and AED use among Chinese university students. A 2023 survey of 1,026 undergraduates at Ningde Normal University (Lin, 2023) highlights this issue starkly: while 85% of respondents recognized the term "AED," only 15% had received hands-on training to operate the device alongside CPR. This suggests most students encounter AEDs passively—perhaps through posters or news reports—rather than through structured education. The study further notes that even medically adjacent majors (e.g., sports science) showed only marginally better performance than humanities students, undermining the assumption that health-related curricula naturally impart emergency response skills. Such findings align with global research showing that without deliberate training interventions, young adults overwhelmingly overestimate their ability to perform lifesaving techniques during actual cardiac emergencies.

2.2

The legal implications of using Automated External Defibrillators (AEDs) in emergency situations present unique challenges that require specialized legal consideration. Unlike basic first aid procedures, AED operation demands technical

proficiency, raising critical questions about appropriate user qualifications and liability protections. Current Chinese regulations reveal a fragmented approach, with local jurisdictions like Shanghai and Shenzhen restricting AED use to "trained personnel" (Liu, 2025), while national legislation remains silent on these specific requirements.

This regulatory patchwork creates significant uncertainty. On one hand, the Civil Code's Article 184 offers broad disclaimer protections for all voluntary rescuers. On the other hand, many local regulations implicitly suggest that only trained individuals should operate AEDs, creating potential contradictions in legal interpretation (Liu, 2025). The situation becomes more complex when considering public venue obligations - while some localities mandate AED installation, most fail to enforce corresponding staff training requirements, potentially undermining the devices' lifesaving efficiency.

Liu (2025) particularly highlights the tension between encouraging public emergency response and ensuring proper AED use. The current system's ambiguity may inadvertently discourage both potential rescuers (concerned about liability) and venue operators (hesitant to install devices without clear legal guidelines). This analysis suggests the need for a more coherent national framework that would clearly define authorized AED users, establish appropriate liability standards based on rescuer qualifications, and create enforceable requirements for public venue preparedness.

The absence of such comprehensive regulations represents a missed opportunity to improve emergency response outcomes while providing necessary legal safeguards. Future policy development should address these gaps to fully realize the potential of public-access AED programs in China.

2.3

The timely delivery of Automated External Defibrillators (AEDs) during cardiac emergencies in high-rise buildings presents a significant challenge that requires innovative solutions. A 2025 patent by Suzhou Yuyue Medical Technology introduces an intelligent dispatch system specifically designed for complex elevator networks in tall buildings. This system addresses the critical need for rapid AED deployment by optimizing coordination between medical equipment and first responders across multiple elevator types and floor configurations. The solution recognizes that conventional emergency protocols often fail to account for the logistical complexities of modern high-rise structures, where different elevator systems serve specific floor ranges with varying speeds and capacities.

At its core, the system employs a sophisticated optimization approach that balances three key objectives: ensuring both AEDs and trained personnel can respond effectively, minimizing the travel distance for AED delivery, and reducing response times for emergency responders. These objectives work together through an algorithm that continuously adapts to real-time conditions, including elevator availability and current passenger loads. The system's two-phase optimization process first identifies potential solution paths across the entire building before refining the most promising options while respecting practical constraints like elevator capacity limits and floor-specific demand patterns.

Practical implementation features make this system particularly valuable for real-world scenarios. It maintains backup dispatch plans in case primary routes become unavailable and incorporates adaptive methods that respond to changing conditions such as elevator traffic congestion. Notably, the system preserves human judgment in

final deployment decisions through its response priority variables, ensuring that automated recommendations can be evaluated and adjusted by trained personnel when necessary. This balance between automation and human oversight represents a thoughtful approach to emergency response technology.

However, several challenges may affect widespread adoption. The costs associated with retrofitting existing elevator systems with AEDs and the necessary sensor networks could prove prohibitive for some buildings, particularly older structures. The system's effectiveness also depends heavily on the availability of trained personnel within the building, potentially limiting its impact in settings with insufficient staff training programs. These implementation barriers highlight the need for cost-effective deployment strategies and comprehensive training initiatives to maximize the system's potential benefits.

Looking ahead, opportunities exist to expand this technology's applications beyond cardiac emergencies. The same principles could potentially be adapted for other time-sensitive medical situations requiring rapid equipment delivery, such as severe allergic reactions or respiratory emergencies. Future developments might also explore shared AED resources between neighboring buildings or integration with smart city emergency response networks. As buildings continue to grow taller and more complex, such intelligent dispatch systems will likely play an increasingly important role in urban emergency preparedness and response infrastructure.

The system represents a significant step forward in integrating emergency medical response capabilities with building infrastructure. By treating AED delivery as a complex optimization problem that accounts for real-world building operations, it provides a practical framework for improving cardiac emergency outcomes in high-

rise environments. The balance it strikes between technological sophistication and practical implementation offers valuable insights for future developments in this critical area of public health infrastructure.

3. Methodology

This study examined how school characteristics influence AED availability and student awareness through a self-designed questionnaire. The survey collected three types of information: participant demographics (academic level and identity), school attributes (type and size...), and AED awareness levels. After testing with 40 participants, plenty of information has been collected.

From 40 completed responses, the data was analyzed using R Studio. Initial examination involved calculating response frequencies and percentages for all questions' answers. The main analysis employed linear regression to test relationships between school characteristics and both AED numbers and awareness levels. Key outputs included p-values and standard deviations to assess significance and variation.

All procedures followed ethical guidelines, with IRB approval obtained prior to data collection. Participant anonymity was maintained throughout the study, with results reported only in aggregate form. The analytical approach ensured rigorous examination of how institutional factors relate to emergency preparedness measures in educational settings.

4. Results

The study examined the relationship between distribution of Automated External Defibrillators (AEDs) as well as the level of knowledge about AEDs among students and staff in Shanghai schools, and school characteristics. Descriptive statistics revealed that 75% of the surveyed schools were senior high schools, with students comprising 95% of the respondents. Regarding AED knowledge, 32.5% reported excellent training, while 5% had no prior knowledge. Approximately 67.5% of schools confirmed the presence of AEDs, though 60% of respondents were unaware of the exact number of devices available. Maintenance records were lacking in most cases (72.5% reported uncertainty). Training experiences varied, with 42.5% having participated in school-organized sessions and an equal proportion expressing interest but lacking training. Notably, only 5% of schools reported incidents of sudden cardiac arrests, and AED usage was confirmed in 17.5% of cases.

Linear regression analysis identified several factors influencing AED distribution and knowledge. The number of AEDs was significantly associated with school area (Estimate std. = 0.19337, $p = 0.0559$), while population, teacher-student ratio, tuition fees, and district showed no significant effects. Training had a negative but non-significant impact (Estimate std. = -0.18537, $p = 0.1337$). For AED knowledge, the teacher-student ratio showed a marginally significant positive association (Estimate = 0.19136, $p = 0.0625$), whereas other variables, including training, did not reach statistical significance.

5. Discussion

The findings of this study provide important insights into the distribution of

Automated External Defibrillators (AEDs) and the level of AED-related knowledge among students and staff in Shanghai schools.

Key Findings and Interpretation

1. AED Availability and Awareness

The study found that 67.5% of surveyed schools reported having AEDs, which suggests a relatively high baseline level of accessibility. However, a significant disconnect exists between AED presence and awareness—60% of respondents were unaware of how many devices were available in their schools. This indicates that merely installing AEDs is insufficient; schools must also ensure that students and staff know where they are located and how to access them in emergencies.

Additionally, maintenance records were largely absent (72.5% uncertainty), raising concerns about device readiness. Without proper upkeep, AEDs may malfunction when needed, making them ineffective in critical moments. This aligns with broader public health research emphasizing that emergency equipment must be both available and properly maintained to be useful.

2. Training and Knowledge Gaps

Only 32.5% of respondents reported excellent prior training in AED use, while 5% had no knowledge at all. Given that AEDs are designed for use by both trained and untrained individuals, the low level of formal instruction is concerning. Even though modern AEDs provide voice-guided instructions, studies show that prior training significantly improves response speed and accuracy during emergencies.

The marginally significant association between teacher-student ratio and AED knowledge ($p = 0.0625$) suggests that schools with more staff per student may have better training opportunities. One unit increase in teacher-student ratio will result in approximately 0.2 increase in the awareness of students about AED. This could be due

to increased capacity for organizing workshops or integrating first-aid education into curricula. However, further research is needed to confirm this relationship.

3. Geographical Influences

A significant finding from this study is the positive correlation between school campus area and the number of Automated External Defibrillators (AEDs) available (Estimate = 0.19337, $p = 0.0559$). One unit increase in campus area will result in approximately 0.2 increase in the number of AED. Larger campuses were more likely to have multiple AED units compared to smaller schools, suggesting that physical space is a key determinant in AED deployment decisions. Comparison with Existing Literature

1. AED Knowledge and Training Deficits

The lack of AED awareness and training in this study mirrors findings from research on college students, where CPR and AED knowledge was often superficial or absent. Many students in such studies expressed willingness to learn but lacked structured opportunities for training. This suggests a systemic gap in first-aid education across educational levels, not just in Shanghai but potentially nationwide.

2. Legal and Operational Challenges

Unlike studies focusing on the legal implications of AED use—such as liability concerns for untrained responders—this research did not explore legal barriers. However, the low training rates imply that schools may not be adequately addressing legal risks associated with improper AED use. Clearer policies and standardized training programs could mitigate these concerns.

3. Technological vs. Human-Centric Approaches

While some studies propose advanced solutions for AED deployment (e.g., smart dispatching systems in high-rise buildings), this study emphasizes human factors—training, awareness, and maintenance. Both approaches are

necessary: even the most efficient AED placement system fails if potential responders lack confidence in using the device.

Study Limitations

1. Small and Non-Representative Sample

With only 40 participants, the statistical power of this study is limited. A larger sample, ideally stratified by school type and staff roles, would strengthen the findings. Additionally, focusing solely on Shanghai schools may not reflect conditions in rural or less-developed regions where AED access could be even more limited.

2. Self-Reported Data Bias

Responses were based on self-assessment, which may overestimate actual knowledge levels. Observational studies or practical tests of AED use could provide more objective measures of competency.

Recommendations for Future Research and Policy

1. Expand Training Programs

Schools should integrate mandatory first-aid and AED training into health education curricula. Partnerships with local hospitals or emergency services could provide practical, hands-on instruction.

2. Improve AED Visibility and Maintenance Protocols

Clear signage and regular drills could increase awareness of AED locations. Maintenance logs should be standardized and audited periodically to ensure device functionality.

3. Policy Development

Governments and educational authorities should establish minimum AED requirements for schools, coupled with funding support for procurement and training. Legal protections for responders should also be widely

communicated to encourage bystander intervention.

6. Conclusion

This study highlights two significant relationships associated with AED, reminding schools with relatively big campus area to install AED or adding additive ones while proposing schools to improve first aid education if a high ratio between students and teachers is present. While AED availability is approved in some schools, their potential life-saving impact is undermined by insufficient education and oversight, the awareness of students about them is also vital. Addressing these issues requires a multi-faceted approach—combining policy mandates, institutional commitment, and community engagement—to ensure that schools are truly prepared for cardiac emergencies.

This research struggles on the relatively small sample size and subjectiveness of some respondents, future research should build on these findings with broader, more rigorous studies to develop evidence-based strategies for improving AED implementation in educational environments globally.

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Appendices

Appendix 1

<u>Variables</u>	<u>Number (Percentage)</u>
Type of school	
Elementary school	1 (2.5%)
Junior high school	9 (22.5%)
Senior high school	30 (75%)
Identity	
Student	38 (95%)
Teacher/Staff	2 (5%)
School doctor	0
Resource manager	0
Knowledge about AED	
Excellent, trained before	13 (32.5%)
Good, but no training before	14 (35%)
Heard about	11 (27.5%)
None	2 (5%)
AED presence	
Yes	27 (67.5%)
No	2 (5%)
I don't know	11 (27.5%)
Number of AED	
One	5 (12.5%)
Two-three	7 (17.5%)
More than four	4 (10%)

I don't know 24 (60%)

AED maintenance

Yes, with record 7 (17.5%)

Yes, no record 3 (7.5%)

No 1 (2.5%)

I don't know 29 (72.5%)

Place to set AED

At least one for each building 11 (27.5%)

At least one for each floor 20 (50%)

Only vital places 9 (22.5%)

AED training experience

Yes, school organized it 17 (42.5%)

Yes, personally joined 2 (5%)

No, but with interest 17 (42.5%)

No, I don't want to 4 (10%)

Presence of sudden cardiac arrests

Yes 2 (5%)

No 27 (67.5%)

I don't know 11 (27.5%)

AED usage

Yes 7 (17.5%)

No 20 (50%)

I don't know 13 (32.5%)

Area of campus

Smaller than 5000 m2s 8 (20%)

5000-10000 m2s 4 (10%)

10001-30000 m2s	5 (12.5%)
30001-50000 m2s	2 (5%)
Bigger than 50000 m2s	3 (7.5%)
I don't know	18 (45%)

Number of people

Fewer than 500	2 (5%)
500-1000	9 (22.5%)
1001-2000	8 (20%)
2001-5000	8 (20%)
More than 5000	1 (2.5%)
I don't know	12 (30%)

Teacher-student ratio

Smaller than 1:5	3 (7.5%)
1:6-1:10	12 (30%)
1:11-1:20	4 (10%)
1:21-1:30	5 (12.5%)
Bigger than 1:30	0
I don't know	16 (40%)

Tuition fee

Fewer than 5000rmb/year	2 (5%)
5000-10000rmb/year	2 (5%)
10001-30000rmb/year	14 (35%)
30001-50000rmb/year	0
More than 50000rmb/year	11 (27.5%)
Free	5 (12.5%)
I don't know	6 (15%)

Location in Shanghai (district)

Huangpu	1 (2.5%)
Xuhui	3 (7.5%)
Yangpu	2 (5%)
Pudong new area	24 (60%)
Minhang	5 (12.5%)
Baoshan	3 (7.5%)
Jiading	1 (2.5%)
Qingpu	1 (2.5%)

First aid training with AED last year

Zero	12 (30%)
One	17 (42.5%)
Two	2 (5%)
More than three	2 (5%)
I don't know	7 (17.5%)

Linear regression analysis (Appendix 2)

<u>Variable</u>	<u>Estimate Std.</u>	<u>P value</u>
Number of AED		
Area	0.19337	0.0559
Population	0.11017	0.3102
Ratio	0.09953	0.3432
Tuition fee	0.09287	0.3406
District	0.08548	0.2412
Training	-0.18537	0.1337
Knowledge		
Area	-0.12636	0.1862
Population	-0.02453	0.8124
Ratio	0.19136	0.0625
Tuition fee	0.03821	0.6810
District	0.03486	0.6153
Training	-0.12524	0.2867