Automated External Defibrillator Issues and Challenges in Saudi Arabia: Knowledge Assessment among Laypersons; Public Safety Perspective

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Research article

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Abstract

Background: A layperson is the first one who attends the scene in the case of Out-of-Hospital Cardiac Arrest (OHCA). Cardiopulmonary Resuscitation (CPR) is not enough for those patients; they need Automated External Defibrillator (AED) to bring the heart to function normally. This study aimed to assess the current status of CPR & AED knowledge among laypersons.

Methods: Using a descriptive design, study was conducted at seven malls located in the Eastern Province of Saudi Arabia. Two hundred fifty participants were surveyed using American Heart Association (AHA) 2015 guidelines to assess CPR & AED knowledge.

Results: The sample mean age was 32.60 years (SD = 10.02), and (87%) of participants working as security personnel. The mainstream of the participants did not receive training about CPR & AED (75.8%, 95.2% respectively). Common misconceptions are fall into all categories of CPR & AED knowledge. Correctly answered statements ranged from (7.2%) in compression rate to (24.2%) in hand placement).

Conclusions: The study results indicated a poor training of CPR & AED in public settings. Integrating high quality CPR & AED knowledge within the school and college curricula is a vital need. National policy adopted by stakeholders’ and decision maker to improve public awareness of CPR & AED and maximize the survival rate. AED public access needs to empower health care system and support community safety regarding Emergency Cardiovascular Care in public settings.

Keywords: Automated External Defibrillator; Cardiopulmonary Resuscitation, Layperson; Out of Hospital Cardiac Arrest; Saudi Arabia.

Background

Cardiovascular disease is a leading cause of worldwide mortality, accounting for approximately 17 million deaths yearly [1]. Approximate 50 to 110 per 100,000 Out of Hospital Cardiac Arrest (OHCA) annual incidence in United States and Europe populations [2, 3]. In the United States, only 10.4% of OHCA who had received resuscitation from Emergency Medical Services (EMS) survived to hospital discharge [3]. In Saudi Arabia, cardiovascular disease mortality rate is 37% according to the World Health Organization (WHO) statistics [4]. A study conducted in Riyadh city in Saudi Arabia reported a high mortality rate of 95.8% among adult OHCA patients; this study reported that poor training of the Cardiopulmonary Pulmonary Resuscitation (CPR) and non-utilization of Automated External Defibrillator (AED) might be the major factors that stand behind the OHCA high mortality rate [5]. Similarly, the study which was conducted among laypersons in 2018 at Jeddah city the second largest city in Saudi Arabia, revealed that the participants perceived a lack of knowledge regarding CPR [6].

Emergency Cardiovascular Care (ECC) 2020 impact goals focus on and make a great effort to doubling cardiac arrest survival rates and out-of-hospital layperson response [7, 8]. Laypersons form the first three links (Recognition and activation of the emergency response system, immediate high-quality CPR, rapid
defibrillation, basic and advanced EMS, advanced life support and post arrest care) of American Heart Association (AHA) to improve the survival rates of adult chain of survival OHCA [9–11].

Chain of survival can be improved through activating the community role by increasing the public awareness regarding the AED needs and outcome [10, 12–14]. The AHA Highlights 2017 recommendations support the laypersons hands on training to perform CPR for OHCA adult victims [10]. CPR alone is not enough, the AEDs are important to restore the normal sinus rhythm and to bring the heart to function normally [12, 15]. Early CPR and AED utilization by laypersons may assist life-saving and it's associated with a two- to three-fold increase in survival when compared to victims who had no CPR & AED before the EMS arrival [9, 13, 16]. Additionally, for most victims AED is not offered until the EMS crews reach the scene, and for every minute delay in defibrillation the chances of survival decline by 10%, so familiarity with Public Access Defibrillation (PAD) may enable rapid defibrillation before EMS arrival [17].

Despite the efforts of focus on the utilization of AED, there are still a lot of AED issues and challenges; research suggests that laypersons face challenges regarding the utilization of AEDs [18]. Moreover, the laypersons are afraid from AEDs that might be dangerous, complicated technically, and difficult to use, because of their limited knowledge and familiarity with them [19].

In Saudi Arabia, 2030 Royal vision was built around three themes: a vibrant society, a thriving economy and an ambitious nation. A vibrant society is supported by an empowering social and health care system. Layperson is the first one who attends the scene in the case of OHCA. Thus, this study aimed generally to assess the need for AED public access that might empower health care system and support community safety regarding ECC in public settings following 2030 vision. Specifically the study aimed to assess the current status of CPR & AED knowledge among laypersons in Saudi Arabia.

**Methods**

**Study Design, Sample, and Setting**

A descriptive design was used to assess the current status of CPR & AED knowledge among laypersons in Saudi Arabia.

The study was conducted over a period of three months in seven major malls located in Dammam and AL Khobar, Eastern Province of Saudi Arabia. The inclusion criteria for this study were all employees in the selected malls namely the security guards and administrators who were able to understand written Arabic.

The estimated sample size was calculated using the Power Primer (Cohen, 1992). The test revealed that using a desired power of 0.80, medium effect size (r = 0.25), and 0.05 level of significance, the estimated sample size was 200 mall staff. Over-sampling was utilized to gain increased understanding, as well as to overcome participant attrition. Thus, 250 mall employees were selected to participate in the study.
Instruments

The study utilized anonymous self-reported questionnaires. The questionnaire had been designed according to 2015 AHA guidelines and 2017 AHA highlights, and it was adapted to be used in this study. This questionnaire was utilized by many studies to assess the laypersons knowledge of Adult CPR & effective use of AED [10, 11, 15]. The questionnaire was translated and back translated by bilingual PhD holders. A pilot study was conducted to evaluate the clarity and appropriateness of the questionnaire to Saudi Arabia culture.

The questionnaire included two parts. Part one a demographic data sheet that includes questions designed to elicit information about participants’ demographic characteristics, such as their age, gender, level of education, job title, whether they have received CPR & AED training or not, additional questions regarding information about the source of CPR & AED training, witnessing cardiac arrest cases while working, and AED device availability in the workplace. The second part includes statements to assess the knowledge of adult CPR & AED utilization. It includes: whether or not they know the EMS number in Saudi Arabia, steps of CPR performance such (Depth, rate, hand placement and compression - ventilation ratio), and the universal steps of AED operation.

Pilot study

A pilot study was conducted at one of the selected malls to test the instrument’s psychometric properties, the time required to complete the questionnaire and its clarity. Twenty participants completed the questionnaire within 5–15 minutes. The psychometric evaluation of the English version of the questionnaire was evaluated by content validity. However, the internal consistency of the questionnaire was measured using the Cronbach’s Alpha (α) coefficient. Reliability revealed an alpha coefficient of 0.71.

Ethical considerations

An ethical approval was obtained from the Institutional Review Board (IRB) of Imam Abdulrahman Bin Faisal University (Reference number: IRB –2019–03–155). A standard code of ethics for participants and the requirements of the IRB were followed. The study package included an introductory letter explaining the purpose of the study. The participants were informed that their participation was voluntary, they have the right to withdraw from the study at any time without penalty and that all the information obtained would be treated confidentially and anonymously. The informed consent obtained from study participants was written. A consent form was attached to the questionnaire. All questionnaires and study materials were kept in a secured cabinet in the principal investigator's office.

Data collection and procedures
Data was collected from March 1st to May 30th, 2019. Permission was also obtained from the Malls administration. The participants were approached in the work setting and the questionnaire was distributed at the end of the work. The researchers and the administration decided when and how to approach possible participants. Participants were informed about the purposes of the study. The informed consent obtained from study participants was written. They were provided with the questionnaire along with a cover letter.

**Data analysis**

The data were coded using the SPSS version 21 (SPSS, Inc., Chicago, IL, USA). Data were screened for missing data and outliers. No missing values and outliers were found. To meet the study aim, descriptive statistics was applied to data.

**Results**

**Demographic data**

A total of 250 questionnaires were distributed; 207 (82.8%) were returned. The features of the participants are displayed in (Table 1).

**CPR and AED training status**

The majority of 157 (75.8%) participants reported having received no training about CPR. The mainstream of the participants stated that they received training through accredited CPR course (9.7%). However, 197 (95.2%) of the participants reported having received no training about AED. As well as, the AED device is not available in all working areas, with (14%) of the participants stated that they had previously witnessed sudden cardiac arrest as descried in (Table 1).

**Knowledge about CPR and AED**

In Table 2, the top misconceptions (fallacies) about the knowledge of adult CPR & AED among participants are presented. It is clear that participants’ most common misconceptions are not limited only to one aspect of CPR performance or AED, but fall into all main categories: the compression - ventilation ratio (90.8%), the adult compression rate (92.8%), the adult compression depth (84.5%), the hand placement in adult CPR (75.8%), and the universal steps of AED operation (92.3%).

**Discussion**

This study aimed to assess the current status of CPR & AED knowledge among laypersons in Saudi Arabia. The findings of the study showed that the majority of the participants have a secondary level of
education, and the rate of participants who received no CPR training was displayed to be 75.8%. As well as, the participants who received no AED training were found to be 95.2% as shown in (Table 1).

Different countries have conducted several studies in their societies to assess the knowledge and awareness regarding CPR & AED utilization [6, 14, 20–26]. CPR training rates in other countries were as follows: in the western region at Jeddah in Saudi Arabia (28.7%) [6], and similar rate (29%) in Jordan [21]. Additionally, (21%) in Hong Kong [24], (35%) in Japan [14], (74%) in New Zealand [26], (75%) in Poland [27], (79.3%) in Washington [25], (68%) in Australia [23], in Sweden (45%) [22], and (40.3%) in Turkey [20]. This can be explained by the fact that it's obligatory to have CPR training by the Law of Occupational Health and Safety in these countries [6, 14, 20–25].

However, in Saudi Arabia, the results indicated that CPR & AED training might be primarily occurring informally as evidenced in table 1, and that the (14 %) of participants stated that they had previously witnessed sudden cardiac arrest. Similarly, (15.8%) at Jeddah in Saudi Arabia [6], (18.6%) in Turkey [20], (19%) in Japan [14], and (23.3%) in Jordan [21]. This can be explained by the fact that the participants are hesitant to apply CPR & AED universal steps since they don't have enough knowledge to perform CPR & AED effectively [6]. They are also afraid to make a mistake particularly with no AED device available in their workplace [19]. Many studies explained that poor availability, adequacy, distribution of AED, and training might be major factors that stand before the OHCA high mortality rate [5, 6, 14, 21].

Quality of CPR concepts were evaluated; compression depth and rates and hand placement. The rates were found to be significantly higher in participants who received CPR training than in those who did not received CPR training. The results indicated that the participants held a considerable number of misconceptions about CPR & AED utilization, and they had insufficient knowledge about the core, and principles of CPR & AED universal operation steps. These results are partially consistent with previous studies in regard to poor knowledge of CPR & AED utilization [5, 6, 20, 21, 24, 26, 28]. However, some aspects were different in Saudi Arabia. This might refer to the status of CPR & AED utilization, and the structured community safety programs for CPR & AED awareness and public access are not available in Saudi Arabia. On top, CPR & AED services are limited to some hospitals as training courses. Further research to examine the availability, adequacy, distribution, and need of CPR & AED training in Saudi Arabia are strongly recommended. Another explanation for the poor knowledge of CPR & AED could be the lack of education content about it in school and college curricula. However, in other countries it is obligatory to have CPR & AED courses before driving license and they are integrated into secondary schools curricula in some courtiers such as Austria, Japan, Norway, Hong Kong and Singapore [14, 20, 23–25].

**Limitations**

Considering the importance of the studied issue, the study involved a small sample of laypersons from seven malls only, and the findings may not be representative of the status of CPR & AED knowledge among laypersons in other settings. Also, the use of a self-report questionnaire could introduce bias, in
that participants might not always give full descriptions of their CPR & AED training experience. As well, this study was limited to one area located in the Eastern Province of Saudi Arabia, which limits the external validity of the findings. Future research should include additional studies with a larger sample size recruited from other community settings such as airports, mosques and football stadiums. More descriptive studies are still needed to gain a comprehensive understanding of the outcomes of CPR & AED training in Saudi community settings. This is an important step before moving to interventional studies. Polit & Beck, in (2010) advised that interventions often fail because they are designed without an adequate understanding of the problem and the relationship between variables [29].

**Conclusions**

The results of this study show that participants have insufficient knowledge about adult CPR & AED universal operation steps. The knowledge and awareness level of CPR and utilization of AED among adults in the public settings can be increased by generalizing CPR & AED training to the public; by this means, the rate of witnesses who start CPR can be raised. Repeating this training at certain intervals will reinforce CPR & AED training in the public settings. Moreover, this study indicates the importance of continuing training the laypersons about CPR & AED universal operation steps.

The media can play a vital role in increasing the knowledge of the public. Thus, the authors promoting the training programs in the media, utilizing cheap and effective technologies such as social media to reach the general population. The common communication instruments in today's world must be developed to contribute to standard CPR education by providing more formal instructions through schools and universities curricula. In addition, national laws should support CPR & AED training in the public settings such as airports, mosques and football stadiums. Thus, the study results indicated that it is the stakeholders’ responsibility to improve the public awareness of CPR and the effective utilization of AED. More descriptive studies are still needed to gain a comprehensive understanding of the quality of CPR and the effective utilization of AED in the public settings. All of that have to be supported with an effective practical system to enhance public safety and maximize the survival rate.

**Abbreviations**

OHCA: Out-of-Hospital Cardiac Arrest; CPR: Cardiopulmonary Resuscitation; AED: Automated External Defibrillator; AHA: American Heart Association; EMS: Emergency Medical Services; WHO: World Health Organization; ECC: Emergency Cardiovascular Care; PAD: Public Access Defibrillation; IRB: Institutional Review Board.

**Declarations**

**Ethics approval and consent to participate**
This study was approved by the IRB of Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (Reference number: IRB – 2019–03–155). The informed consent obtained from study participants was written and attached to the questionnaire.

**Consent for publication**

Not applicable.

**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors’ contributions**

All authors have made significant contributions to this study and have approved the final version of this manuscript. SA was responsible for the study conceptualization and design, literature review, data analysis, and manuscript development. OK was responsible for the literature review, data analysis, and manuscript development. MK & MA were responsible for the data analysis and manuscript development. FMA, FSA, HA were responsible for the data collection and manuscript development. H.E & MAA were responsible for the manuscript development. AA, MSA, SHA were responsible for the literature review and manuscript development.

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Tables
| Characteristics                        | Result                                      |
|---------------------------------------|---------------------------------------------|
| **Age**                               | Mean 32.60 years (SD 10.02)                 |
| **Gender**                            |                                             |
| Male                                  | 178 (86%)                                   |
| Female                                | 29 (14%)                                    |
| **Level of education**                |                                             |
| Less than secondary education         | 56 (27.1%)                                  |
| Secondary education                   | 111 (53.6%)                                 |
| College education                     | 21 (10.1%)                                  |
| University education                  | 19 (9.2%)                                   |
| **Job title**                         |                                             |
| Administrator                         | 27 (13%)                                    |
| Security personnel                    | 180 (87%)                                   |
| **Receive any training covering CPR** |                                             |
| Yes                                   | 50 (24.2%)                                  |
| No                                    | 157 (75.8%)                                 |
| **Receive any training covering AED** |                                             |
| Yes                                   | 10 (4.8%)                                   |
| No                                    | 197 (95.2%)                                 |
| **Source of CPR and AED training**    |                                             |
| Web/computer                          | 4 (1.9%)                                    |
| Accredited CPR course                 | 20 (9.7%)                                   |
| Training books/written materials       | 1 (0.5%)                                    |
| Video presentation                    | 1 (0.5%)                                    |
| Didactic lecture                      | 8 (3.9%)                                    |
| Internal institute training            | 16 (7.7%)                                   |
| **Witness cardiac arrest cases while working** |                      |
| Yes                                   | 22 (14%)                                    |
| No                                    | 178 (86%)                                   |
| **AED device availability in workplace** |                                         |
| Yes                                   | 0 (0%)                                      |
| No                                    | 207 (100%)                                  |

SD = Standard Deviation; CPR = Cardiopulmonary Resuscitation; AED = Automated External Defibrillator
TABLE 2. Descriptive results of participant’s answers on the knowledge of adult CPR & AED

| Item | Question | Item participants answers |
|------|----------|---------------------------|
|      |          | Correct Frequency (%)     | Wrong Frequency (%) |
| 1    | The EMS number in Saudi Arabia is? (T\(^B\))<br>A. 996<br>B. 997 | 95(45.9) | 112(54.1) |
| 2    | The adult compression - ventilation ratio for 1 or 2 rescuers is? (T\(^B\))<br>A. 15:2<br>B. 30:2 | 19(9.2) | 188(90.8) |
| 3    | The adult compression rate is? (T\(^B\))<br>A. 80 – 100 / min<br>B. 100 – 120 / min | 15(7.2) | 192(92.8) |
| 4    | The adult compression depth is? (T\(^A\))<br>A. At least 2 inches (5 cm)<br>B. less than 2 inches (5 cm) | 32(15.5) | 175(84.5) |
| 5    | The hand placement in adult CPR is? (T\(^A\))<br>A. Two hands on the lower half of the breastbone (sternum)<br>B. Two hands on the middle of the breastbone (sternum) | 50(24.2) | 157(75.8) |
| 6    | When the AED device arrives, what should you do next? (T\(^B\))<br>A. Attach pads, power on, analyzing and follow AED Prompts.<br>B. Power on, attach pads, analyzing and follow AED Prompts. | 16(7.7) | 191(92.3) |

EMS = Emergency Medical Services; T\(^A\) = True choice A; T\(^B\) = True choice B; CPR = Cardiopulmonary Resuscitation; AED = Automated External Defibrillator