



# Current knowledge of cardiopulmonary resuscitation among the university population of central-western Mexico

## Conocimiento actual de la reanimación cardiopulmonar en la población universitaria del centro-occidente de México

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Cardiopulmonary resuscitation, cardiac arrest, sudden death, university, Mexico.

### Palabras clave:

Reanimación cardiopulmonar, paro cardiaco, muerte súbita, universidad, México.

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### ABSTRACT

**Introduction:** Out-of-hospital cardiac arrest is a leading cause of global mortality; it is estimated that each year 33,000 to 53,000 people die from sudden death in Mexico. Cardiopulmonary resuscitation (CPR) learning at younger ages has shown promising results, prompting the recommendation of CPR training in the high-school curricula. Currently, there is no information about CPR knowledge in the university population of our country. **Objective:** We aimed at estimating the level of knowledge and attitude towards CPR among the university students of central-western Mexico. **Material and methods:** A cross-sectional, descriptive study was conducted among the students of 30 Mexican university centers between February and March 2020; a self-administered questionnaire was distributed to the participants. All data were collected and statistically analyzed. **Results:** Two hundred ninety-four ( $n = 294$ ) students were included (mean age  $21.04 \pm 1.95$  years). Although 37% of students had been previously trained, only 12.9% could give an accurate description of the CPR technique. Notably, 98.9% of the participants desire to receive additional CPR training, and 57.1% would be willing to act if they had the appropriate prior knowledge. Health science students had the highest number of correct answers among other academic areas ( $p = 0.001$ ). **Conclusions:** Despite the evidence supporting CPR training and familiarization with automated external defibrillators at younger ages, Mexico has no laws to promote them in the high-school curricula. The poor outcomes obtained reinforce the necessity for better health policies and practical CPR training, probably through innovative methods that allow retention of knowledge.

### RESUMEN

**Introducción:** El paro cardiaco extrahospitalario es una causa importante de mortalidad global; se estima que cada año mueren entre 33,000-53,000 personas a causa de muerte súbita en México. El aprendizaje de reanimación cardiopulmonar (RCP) a edades tempranas ha mostrado resultados prometedores, recomendando incluir su entrenamiento dentro del currículum escolar. Actualmente, no existe información acerca del conocimiento en RCP de la población universitaria de nuestro país. **Objetivo:** Estimar el nivel de conocimiento y actitud frente a RCP en estudiantes universitarios del Centro-Occidente de México. **Material y métodos:** Un estudio transversal y descriptivo fue realizado en estudiantes de 30 centros universitarios entre febrero-marzo de 2020, un cuestionario autoadministrado fue distribuido a los participantes. La información fue recolectada y analizada estadísticamente. **Resultados:** Doscientos noventa y cuatro estudiantes ( $n = 294$ ) fueron incluidos (edad media  $21.04 \pm 1.95$  años). Pese a que 37% de los estudiantes había sido previamente entrenado, únicamente 12.9% fue capaz de detallar correctamente la técnica de RCP. Notablemente, 98.9% estaría dispuesto a recibir aprendizaje adicional y 57.1% estaría dispuesto a actuar si tuviera los conocimientos previos adecuados. Los estudiantes de ciencias de salud tuvieron el mayor número de respuestas correctas frente a otras áreas académicas ( $p = 0.001$ ). **Conclusiones:** Pese a la evidencia a favor del aprendizaje en RCP y familiarización con desfibriladores externos automáticos a edades tempranas, México no cuenta con alguna legislación para incluirlo en el currículum escolar medio-superior. Los pobres resultados obtenidos refuerzan la necesidad de mejores políticas en salud y un entrenamiento práctico en RCP, probablemente mediante métodos innovadores que permitan la retención del conocimiento

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## INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is a leading cause of global mortality.<sup>1</sup> It is defined as the loss of functional cardiac mechanical activity, and consequently, loss of systemic circulation outside a hospital. There is no exact data on its incidence in Mexico since a considerable number of events are not registered.<sup>2</sup> Sudden cardiac death (SCD) is responsible for approximately 30% of all cardiovascular deaths;<sup>3</sup> some authors have calculated that approximately 33,000 to 53,000 SCDs occur per year in our country.<sup>4</sup> Survival rates vary across the world (from 3 to 22%); they depend directly on the skills and knowledge about cardiopulmonary resuscitation (CPR) of the first witness, where the sooner the chain of survival is activated, the higher probability of the victim's survival.<sup>5,6</sup> Between 10-65% of OHCA victims receive CPR, depending on their geographical situation.<sup>7-9</sup>

Early and effective CPR can prolong the window of opportunity for successful defibrillation with the presence of shockable rhythms: ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT). If no care is provided, the chance of survival decreases by 7-10% for every minute of CPR delay.<sup>10</sup> Besides, after survival, the probability of favorable neurological outcomes at one month decreases by 4-8% for every minute of CPR delay.<sup>11</sup> For better outcomes, an automatic external defibrillator (AED) must be available to reach the patient in 4-5 minutes,<sup>12</sup> but usually, the first defibrillation by health care providers is delayed beyond this period.<sup>13</sup> Some Mexican states have implemented cardio-protected areas (ideally any place with the potential to gather more than 500 people at a time) to allow easy access to AEDs.<sup>6,14</sup>

In our country, the chain of survival is based on identifying the victim, emergency medical services (EMS) activation through the 9-1-1 call requesting an AED, and CPR initiation (hands-only or compressions plus ventilation support).

Despite the effort to teach the population basic CPR techniques, poor outcomes have persisted for almost 30 years.<sup>1,8</sup> These results can be improved by a coordinated effort to optimize the local chain of survival. Positive

outcomes have been recorded in some regions where weaknesses in the chain are identified and corrected.<sup>15,16</sup>

The proportion of CPR trained individuals fluctuates in different countries. The main reason for this variation is the difference between various educational systems, such as CPR training as part of the scholar curricula; no time and no interest to learn CPR, afraid of doing something wrong, a fear of legal liability, and other reasons are obstacles that limit the scope of CPR.<sup>17</sup> Developed countries report that even more than half of their university students had been trained in CPR techniques; these countries also show better OHCA outcomes.<sup>18-21</sup> In contrast, developing countries have shown lower rates of CPR training in their population.<sup>17,22</sup>

Some authors have proposed to start CPR learning at younger ages, where satisfaction and confidence levels are higher.<sup>23</sup> Evidence supports the implementation of CPR training and the familiarization of how to use an AED at schools;<sup>5</sup> over the long term, children and teenagers trained in CPR will contribute to the number of adults with knowledge about CPR in the community, increasing the number of witnesses willing to act. Despite the degradation of CPR skills, prior learning improves performance compared with untrained individuals.<sup>24</sup>

Schools represent an ideal opportunity since they allow access to a large part of the population with a well-defined structure.<sup>7</sup> However, there are currently no studies assessing the prevalence of university students with knowledge about CPR in Mexico.

*Objective:* The main goal was to estimate the level of knowledge and attitude towards CPR among the university population of central-western Mexico.

## MATERIAL AND METHODS

*Study design:* A cross-sectional, descriptive study was carried out between February and March of 2020. An anonymous survey made by the authors was used to determine the knowledge about CPR, previous training status, and willingness to learn and act in a real-world scenario. All participants gave their consent to realize this study.

**Settings and study subjects:** The study was conducted by medical students from the University of Guanajuato. Inclusion criteria were: ≥ 18-years-old students who were enrolled in a university at the moment of the study and adequately answered the survey. All medical students were excluded from the analysis. **Survey instrument:** We used an 11-item question survey made on Google Forms platform that included: age, gender, city, university, career, knowledge of the CPR concept, previous training status, the place where the subject was trained, description of the technique (cardiac arrest identification, activation of EMS and rhythm of compressions), willingness to learn and finally, willingness to act in a real-world scenario. The full-scale instrument is shown in [Table 1](#).

**Outcomes:** The primary outcome of the study was to assess prior knowledge of the CPR concept and technique. Secondary outcomes were to know where they had previously gained the knowledge, differences among age, gender, university of origin (public or private), and

academic area to which the student belongs (health, economic-administrative, exact sciences and engineering, architecture and design, or social sciences).

**Data analysis:** We used descriptive statistics to summarize the data; the Microsoft Excel 2010 software was used to organize the data and provide the estimated values. The IBM SPSS software was used to represent the data and compute the Cronbach’s alpha coefficient to obtain the instrument’s internal reliability. The GraphPad software was used to compute the Fisher’s Exact Test values. The  $\chi^2$  test with Yates’ correction was performed by hand using the expression  $\chi^2 = \sum_{i=1}^n ((O_i - E_i) - 0.5)^2 / E_i$ , where  $O_i$  stands for the observed data,  $E_i$  is the expected value, and 0.5 is the correction value.

## RESULTS

We received 312 answered surveys, but only 294 participants (from 30 university centers) who completed the survey adequately and met the criteria were included, demographic features are shown in [Table 2](#); the majority of respondents were female (54.08%), the mean age of the sample was 21.04 years, and 74.14% of the subjects attended public universities; the academic area to which they belong was also assessed, five were distinguished: health sciences (23.12%), economic-administrative (14.96%), exact sciences and engineering (41.94%), architecture, art and design (13.94%), and social sciences (6.46%).

The overall results are in [Table 3](#). Two hundred and fifty students (85%) had ever heard about the CPR concept, but only 37% (n = 109) were trained. Of these 109 participants, 34.9% correctly remembered the CPR technique, while the other 65.1% answered incorrectly. Only 54 of 294 (18.36%) participants were trained at a school; 38 of 294 (12.92%) were able to describe the correct CPR technique; almost all, 291 of 294 (98.97%) were willing to receive additional CPR learning, and finally, 168 of 294 (57.14%) were willing to act in a real-world scenario.

From the last pieces of information and based on the population’s demographic features, we compared the number of correct answers from items I.1-6 between different groups.

Table 1: The survey instrument used to assess demographics, prior knowledge, and attitudes towards the cardiopulmonary resuscitation technique.	
Item	Question
A.1	Age
A.2	Sex
A.3	City in which you study
A.4	University
A.5	Bachelor’s degree
I.1	Are you familiar with the concept of CPR?
I.2	Have you received any training before?
I.3	Where did you receive your prior training?
I.4	Accurate depiction of the technique
I.5	Are you willing to learn?
I.6	Are you willing to be the first one to act with your prior knowledge?

The items A.1-5 assess the population demographic features while the items I.1-6 assess both knowledge and attitudes towards the technique.

**Table 2: Demographic features of the interviewed population.**

Characteristic evaluated		n (%)
Age	Group	
	≤ 21 years	182 (61.90)
	> 21 years	112 (38.10)
Gender	Female	159 (54.08)
	Male	135 (45.92)
Type of school	Public	218 (74.15)
	Private	76 (25.85)
State	Guanajuato	201 (68.37)
	Queretaro	50 (17.01)
	Michoacan	40 (13.60)
	Others (Jalisco, Mexico City)	3 (1.02)
Area	Exact sciences and Engineering	122 (41.50)
	Health sciences	68 (23.13)
	Economic-Administrative	44 (14.97)
	Architecture, Art and Design	41 (13.94)
	Social sciences	19 (6.46)

We compared the number of correct answers between males and females: 88.89 vs 81.76% had ever heard the concept of CPR ( $p = 0.1018$ ); 39.25 vs 35.22% had received CPR training ( $p = 0.5448$ ); 14.07 vs 22.01% received their formation at school, 22.96 vs 11.94% received their training at a first-aid course, and 2.22 vs 1.25% at another site ( $p = 0.0401$ ), for male and female groups, respectively. The item concerning where was the knowledge obtained, displayed a statistically meaningful difference.

In regards to the age comparison, we distinguished two groups: those with 21.04 years of age or younger and those older than 21.04 years, no statistically meaningful items were found, with an overall amount of correct answers between the younger and the older

group of 54.02 vs 55.80% ( $p = 0.4906$ ); 84.61 vs 85.71% were familiar with the concept of CPR ( $p = 0.8673$ ), and 35.16 vs 40.17% had been trained ( $p = 0.4558$ ), for the younger and the older group, respectively.

When comparing those from private versus public schools, no statistically meaningful differences in the items were found, the percentages of correct answers were: 81.57 vs 86.23% of students were familiar with the concept of CPR ( $p = 0.3521$ ), and 31.57 vs 38.99% had received formation ( $p = 0.2722$ ), for private and public schools, respectively.

Finally, when comparing the academic area to which their college degree belongs, there was a statistically meaningful overall difference in the items 1.1-6 together ( $p = 0.001$ ); when comparing the individual items, only item number 1 (1.1) displayed a statistically meaningful difference: 94.11% of health students, 72.73% of economic-administrative students, 85.24% of exact sciences and engineering students, 82.92% of architecture and design students, and 84.21% of social sciences students were familiar with the concept of CPR ( $p = 0.043$ ).

The remaining items and their percentages are shown in [Table 4](#).

## DISCUSSION

Although high-quality CPR has been a significant advance in OHCA care, CPR knowledge levels in Mexico remain low. Bystanders play a crucial role before the EMS arrives;<sup>8,25</sup> for this reason, the implementation of massive CPR teaching programs seeks to increase the number of bystanders willing to act.

Recently, the American Heart Association (AHA), the European Resuscitation Council (ERC), and the World Health Organization (WHO) endorsed the recommendation to train schoolchildren in CPR.<sup>26</sup> There is an international trend in implementing mandatory CPR education in the scholar curricula.<sup>27-30</sup> Consequently, there is an increase in training at younger ages; interestingly there is also a demonstrated increase in training at all ages, which has suggested a greater diffusion, awareness, and initiative for CPR training among adults, even schoolchildren could reach relatives and friends.<sup>31,32</sup>

In our study, 12.9% of all university students knew the correct CPR technique and 37% had been trained in CPR at some point in their lives, nonetheless only about a third (34.8%) of them were able to describe the CPR technique correctly, reflecting a lack of knowledge retention even among trained students. CPR teaching could be improved with the implementation of high-fidelity medical simulation programs, attached to current guidelines.<sup>33</sup>

Compared with other series, our cohort has lower rates of previous CPR training against developed and high-income countries (as Norway, Denmark, USA, Portugal, and Japan)<sup>19,21,28,29,31</sup> but is similar to those found in upper-middle, lower-middle and low-income countries (as China, Turkey, and Malaysia).<sup>17,34</sup> Unfortunately, to this date, Mexico has no programs

to implement mandatory CPR training in the scholar curricula; we face several barriers to improve these health policies, especially their economic cost and trainer availability.<sup>35</sup>

Although we did not find a significant difference between students' knowledge from the public and private universities, socioeconomic status is likely a key determinant of access to CPR learning and survival rates,<sup>27,36</sup> since many low-income students fail to reach a university education, we do not know their current status in our country. This problem also represents the situation in low-income cities and neighborhoods, where the impact of cardiac disease is disproportionately felt. Gender may play a role in the acquirement of CPR knowledge since one item was found statistically significant ( $p = 0.0401$ ), showing that the

**Table 3: Overall survey results about knowledge and attitude towards cardiopulmonary resuscitation.**

Item assessed	Answer	n (%)
Are you familiar with the concept of CPR?	Yes	250 (85.03)
	No	44 (14.97)
Have you received any CPR training before?	Yes	109 (37.07)
	No	185 (62.93)
If so, where did you receive your prior training?	School	54 (49.54)*
	First-aid course	50 (45.87)*
	Other (work, by a relative)	5 (4.59)*
Accurate depiction of CPR technique (identification, activation of EMS and rhythm of compressions)	Correct	38 (12.93)
	Incorrect	71 (24.15)
	Not answered	185 (62.92)
Are you willing to learn?	Yes	291 (98.98)
	No	3 (1.02)
With the previously acquired knowledge, would you be willing to act in a real-world scenario?	Yes	168 (57.14)
	No	13 (4.42)
	I am not sure	113 (38.44)

CPR = cardiopulmonary resuscitation, \* Over the n = 109 trained.

**Table 4: Breakdown of the frequencies of correct answers obtained per group compared.**

N = 294 subjects n (%)			
Item	Male n = 135	Female n = 159	p value (Fisher's exact test)
Overall	506/810 (62.46)	589/954 (61.74)	0.164
I.1	120 (88.89)	130 (81.76)	0.1018
I.2	53 (39.25)	56 (35.22)	0.5448
I.3			
School	<b>19 (14.07)</b>	<b>35 (22.01)</b>	<b>0.0401*</b>
First-aid course	<b>31 (22.96)</b>	<b>19 (11.94)</b>	
Other	<b>3 (2.22)</b>	<b>2 (1.25)</b>	
I.4	18 (13.34)	20 (12.57)	0.8632
I.5	132 (97.78)	159 (100.00)	0.0957
I.6	82 (60.74)	86 (54.08)	0.2875
<b>Groups compared by gender n (%)</b>			
Item	≤ 21.04 years-old n = 182	> 21.04 years-old n = 112	p value (Fisher's exact test)
Overall	590/1,092 (54.02)	375/672 (55.80)	0.4906
I.1	154 (84.61)	96 (85.71)	0.8673
I.2	64 (35.16)	45 (40.17)	0.4558
I.3			
School	33 (18.13)	21 (18.75)	0.7919*
First-aid course	28 (15.38)	22 (19.64)	
Other	3 (1.64)	2 (1.78%)	
I.4	25 (13.73)	13 (11.60)	0.7209
I.5	180 (98.90)	111 (99.10)	1
I.6	103 (56.59)	65 (58.03)	0.9035
<b>Groups compared by age n (%)</b>			
Item	Private school n = 76	Public school n = 218	p value (Fisher's exact test)
Overall	235/456 (51.53)	730/1,308 (55.81)	0.1261
I.1	62 (81.57)	188 (86.23)	0.3521
I.2	24 (31.57)	85 (38.99)	0.2722
I.3			
School	15 (19.73)	39 (17.88)	0.3593*
First-aid course	8 (10.52)	42 (19.26)	
Other	1 (1.31)	4 (1.83)	
I.4	7 (9.21)	31 (14.22)	0.3234
I.5	75 (98.68)	216 (99.08)	1
I.6	43 (56.57)	125 (57.33)	1
<b>Groups compared by school type (private vs public) n (%)</b>			

Continue to Table 4: Breakdown of the frequencies of correct answers obtained per group compared.

Item	H n = 68	EA n = 44	EI n = 122	AD n = 41	S n = 19	p value ( $\chi^2$ test)
Overall	<b>259/408 (63.48)</b>	<b>128/264 (48.49)</b>	<b>386/732 (52.73)</b>	<b>130/246 (52.84)</b>	<b>62/114 (54.83)</b>	<b>0.0010</b>
I.1	<b>64 (94.11)</b>	<b>32 (72.73)</b>	<b>104 (85.24)</b>	<b>34 (82.92)</b>	<b>16 (84.21)</b>	<b>0.0438</b>
I.2	35 (51.47)	13 (29.54)	39 (31.96)	15 (36.58)	7 (36.84)	0.0755
I.3						
School	20 (29.41)	7 (15.9)	14 (11.47)	8 (19.51)	5 (26.31)	< 0.1000 <sup>‡</sup>
First-aid course	15 (22.05)	6 (13.63)	23 (18.85)	4 (9.75)	2 (10.52)	
Other	0	0	2 (1.63)	3 (7.31)	0	
I.4	14 (20.58)	3 (6.81)	13 (10.65)	6 (14.63)	2 (10.52)	0.2171
I.5	68 (100)	44 (100)	120 (98.36)	40 (97.56)	19 (100)	> 0.9950 <sup>‡</sup>
I.6	43 (63.52%)	23 (52.27)	71 (58.19)	20 (48.78)	11 (57.89)	0.6114
<b>Groups compared by academic area to which their bachelor's degree pertains, n (%)</b>						

The first line after depicting the group corresponds to the amount of overall correct answers, with a total amount of 1,764 answers; (H = health sciences students, EA = economic administrative students, EI = exact sciences and engineering students, AD = architecture, art and design students, S = social sciences students); \* Indicates the computation of the probabilities by the  $\chi^2$  test, <sup>‡</sup> Indicates that the Yates' correction has been addressed to compute the probabilities; bold characters indicate the item as being statistically significant.

place where CPR concepts are learned, could be influenced by gender, where more women gain their knowledge at schools, and more men gain their CPR knowledge at first-aid courses. The academic area seems to influence general knowledge about CPR, based on a statistically significant difference observed regarding all of the correct answers ( $p = 0.001$ ), where health sciences students had the highest score and economic-administrative students the lowest. However, despite this difference, their results remained suboptimal. From this, we gather that both gender and the academic area may play a role in knowledge and attitudes towards CPR.

Sasson et al.<sup>8</sup> estimate that the number needed to treat (NNT) to survive OHCA due to bystander CPR initiation is between 24 to 36. However, fear of harming the victim, doing mouth-to-mouth breathing, and lack of self-confidence in their abilities remain as significant limitations in our environment.<sup>35</sup> Studies have shown that compression-only CPR is effective and can improve survival outcomes;<sup>37</sup> this is supported because when

cardiac arrest occurs, the average healthy adult has 2 liters of oxygen in his body. Oxygen consumption is approximately 250 cm<sup>3</sup> per minute; thus, this well-oxygenated patient has approximately 8 minutes' worth of oxygen within the body, making chest compressions the main CPR action.<sup>38</sup> For that reason, the AHA has changed their CPR algorithm from A-B-C (Airway-Breathing-Circulation) to C-A-B since 2010,<sup>39</sup> to make sure we provide a high-quality technique, with an adequate chest compression depth (5-6 centimeters) and rate (100-120/minute).

The vast majority (98.9%) of the subjects are willing to learn how to save a life through CPR; nevertheless, their willingness to act in a real-world scenario drops to 57%, data which reflects the interest of the university population to learn CPR in an environment with a lack of opportunities to do so, where 62.9% of the sample had not received CPR training despite attending university. These results should be interpreted as an incentive to promote further private and public initiatives that seek to train the population in resuscitation maneuvers.

### Limitations

This study had several limitations. Firstly, the sample used may not represent the entirety of the Mexican population, considering that the participants are directly related to a higher education level, this may lead to overestimated scores, which may be addressed in the future by promoting a more heterogeneous sample. Secondly, the evaluation of theoretical knowledge may not reflect the real practical skills of the participants. Thirdly, no different items were used to assess the CPR technique step by step. Finally, the instrument was tested for internal reliability using the computation of Cronbach's alpha coefficient; our instrument displayed  $\alpha < 0.7$ , however, this coefficient is dependent on the number of items, being the number of items  $\omega$ ,  $\omega > 10$  is desired to allow the coefficient to determine the internal reliability of the instrument more precisely.<sup>40</sup> Currently, information about CPR in Mexican schools is quite limited. Further work will have to be promoted in this and other populations to determine the current status in our country.

### CONCLUSIONS

Despite the evidence in favor of learning CPR and AED use at younger ages, Mexico has no laws to promote CPR training in the high-school curricula. This population may represent an excellent opportunity to increase the rate of victims receiving adequate care outside a hospital with CPR and early defibrillation in the future. The poor outcomes obtained in this study reinforce the necessity for better health policies and practical CPR training, probably through innovative methods that allow retention of knowledge.

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