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Assessment of Knowledge and Skills of Certified Recovery Instructors in Basic Life Support

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Abstract

The immediate and effective application of Cardiopulmonary Resuscitation is associated with a reduction in mortality in patients with cardiac arrest. The main objective of the European Resuscitation Council (ERC) is to spread the knowledge of BLS, focusing on proper and effective implementation. The development of informatics and the use of educational preforms are useful tools, both in education and in the evaluation of successful CPR implementation. Training with the use of performs, along with appropriate software, results in the objective recording of skills, making it possible to identify errors in real time. Their use can be a valuable tool in assessing the effectiveness of basic life support (BLS) education. The purpose of this research is to evaluate the skills of recovery instructors in CPR using mechanical equipment and objective conditions for assessing the application effectiveness.

Keywords: Cardiac arrest, Mortality rate

1 Introduction

According to studies, immediate and effective application of Cardiopulmonary Resuscitation in combination with other parameters of the chain of survival is of great importance for the survival of the victims of sudden cardiac arrest [5]. Every minute delaying its onset increases the mortality rate by 8-10%. It is also known that the existence of logistical infrastructure is not enough, on its own, but knowledge and education are needed for a successful resuscitation [6].

The main objective of the ERC is to spread the knowledge about conducting BLS in the community by applying the latest guidelines for doing so properly. The ERC (European Resuscitation Council), after research, provided guidelines on how

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chest compressions should be administered, in order to achieve effective resuscitation. The frequency of compressions was set at 100 - 120 per minute, as a limit, and their depth at 5-6 cm [4; 7].

At the same time, conditions, terms and rules to be followed during the training of resuscitators were set, as well as the way of selecting and training the new resuscitators [8]. These guidelines also include criteria for the level of training of BLS instructors, through continuous training and assessment, parameters for which BLS instructors are checked by other, certified BLS peers (9). The ultimate goal is that instructors have a deep knowledge of their subject, not only at a theoretical, but also at a practical level [10-11]. There are studies that argue that the training program alone is not sufficient to ensure a high level of knowledge and competence of BLS for the aforementioned instructors [12-13].

Over time, many studies were conducted, measuring the knowledge and skills of resuscitators regarding Cardiopulmonary Resuscitation, with the use of various assessment methods that are essentially based on the evaluation of knowledge using questionnaires and skills, with subjective graduation by trained trainers [14-15]. The development of informatics, as well as the creation of software that cooperates with educational preforms, made it possible, to measure the qualitative and quantitative features that ultimately lead to a successful Cardiopulmonary Resuscitation [16].

2 Basic Concepts & Definitions

- **QCPR (Quality Cardiopulmonary Resuscitation):** It is the name given to the concept by Laerdal, to characterize the scores given by the software. The higher the percentage score, the more effective is Cardiopulmonary Resuscitation (CPR) is.
- **CPR (Cardiopulmonary Resuscitation):** It is a procedure that takes place in emergency states of (cardiac) arrest and combines chest compressions and rescue ventilations.
- **BLS (Basic Life Support):** It is a step - level of health intervention that is implemented to victims with life-threatening symptoms until specialist care is given by expert healthcare professionals.
- **MCQ (Multiple Choice Question):** It is a knowledge-based questionnaire as structured by the ERC to explore the trainees' knowledge.
- **ERC (European Resuscitation Council):** It is the European Resuscitation Agency, which is responsible for certified education regarding Cardiopulmonary Resuscitation in Europe.
- **Mean depth:** TThe ideal mean depth of compressions during CPR is set for adults to 5-6cm.
- **Mean rate of all compressions during this session:** The compression frequency for effective CPR should be 100 - 120 / min.

- **Ventilations:** It is the number of ventilations during CPR, with the ideal number being 5-6 ventilations / min.
- **Ventilations with adequate volume:** The ideal mean air volume per ventilation is 400-700 ml.
- **Mean rate of all ventilations during this session:** An ideal number of ventilations are considered to be 6-12 ventilations per cycle (one cycle lasts 2 minutes).

3 Material and Methods

The research was conducted in an organized center of certified education in Basic Life Support in Athens, under the aegis of the ERC, in collaboration with the laboratory DIGITHEA Lab (Digital Health Applications and Health Economics Analytics Laboratory) at the University of Peloponnese. The study involved 63 random individuals. The study data have been collected from February to March 2017, with a target population of cardiopulmonary resuscitation instructors.

Respondents were asked to answer 20 knowledge questions adapted to the Greek language, according to the instructions of the clinical adaptation group [29].

The process is the following:

Two independent translators, familiar both with English and Greek, translated the English questionnaire comprising of twenty questions. The two texts translated into the Greek language were taken into account and the common result was given to a third, also independent, translator whose mother tongue is English; the third translator, once more, translated the Greek text into the English language, without, of course, being aware of the original foreign language version of the ERC questionnaire.

They followed the formal process and were evaluated on the basis of the ERC trainee assessment form. During the evaluation, they performed CPR for 2 minutes using the Laerdal Resusci Anne QCPR Manikin as a template, and the data was recorded and stored by Laerdal's Resusci Anne Wireless Skill Reporter software. Data was recorded in the following individual fields:

1. Total score determined by individual parameters such as compressions (number and quality), or ventilations (number and quality), as well as the compression time within the measured session; in our case, a session that lasts 2 minutes.
2. Session data such as time, number of cycles (compressions/ ventilations), and the correctness of the compression point selection.
3. Data on the quality characteristics of compressions, such as frequency, time with sufficient frequency, depth of compressions, as well as adequate - complete chest recovery during compressions.
4. Data on the qualitative properties of ventilations, such as air volume, frequency, successful or not ventilations.

Figure 1: QCPR score

The purpose of the study is to evaluate the skills of resuscitation instructors in the application of Cardiopulmonary Resuscitation using objective criteria / reliable recording, such as that provided by the mechanical and electronic equipment (educational preform and software).

4 Results

The survey involved 63 instructors, with 51.6% of them being men and 48.4% women, and an age range of 22-55 years old, with most of them belonging to the age group of 46-50 years (20.3%), followed by the age group of 21-25 years old with 18.8%, and the age group of 36-40 years old with 15.6%.

Regarding the level of education, 57.8% of the participants in the survey were was higher education graduates, with a postgraduate diploma, while 15.6% of them had a PhD. 42.2% of the participants were secondary education graduates and 6.5% middle education graduates. Of the sample, 76.7% are healthcare professionals, while the remaining 23.3% are not.

From the recording of the ERC evaluation form, which was faithfully followed by the target population as a whole, it was observed that the whole population was fully aware of the algorithm used for the proper realization of Cardiopulmonary Resuscitation

When observing the responses individually, as recorded in the knowledge questionnaire, we find a stratification of the correct answers with questions to be fully known to the respondents, so they give the right answer, at a total of 100%, but at the same time there are questions, which only a small percentage of the respondents were able to know the right answer for a percentage of 35%.

In the evaluation of the sample in the questionnaire as a whole, 79.8% has a success rate of over 70%. This success rate of 70% is comprised of 18.8% of the sample, followed by 14.1% of respondents having chosen 75% of the correct answers to the questionnaire.

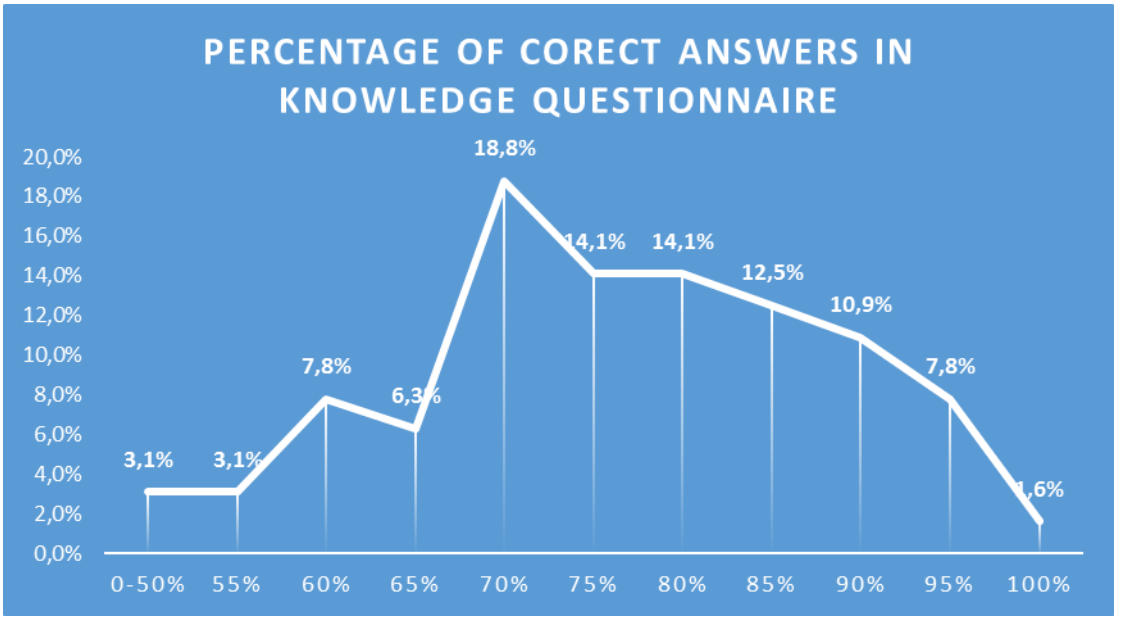

Figure 2: Percentage of Correct Answers in the Knowledge Questionnaire

As far as the results of the General Skill Score of the sample are concerned, we see that 27.9% have a good technique of Cardiopulmonary Resuscitation, 21.3% can be characterized as having excellent technique with a score of 91 - 100%, while a fairly high percentage, reaching 24.6% has a success rate of less than 50% in right answers.

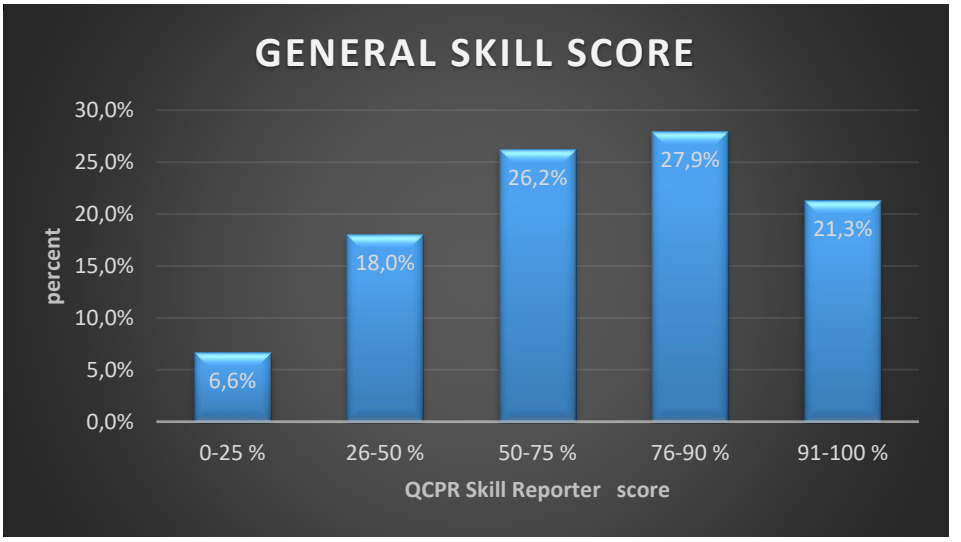

Figure 3: General Score QCPR Skill Reporter

The individual scores show that 54.1% have a good compression score between 71 and 100, while 26.2% has a score of 0-50.

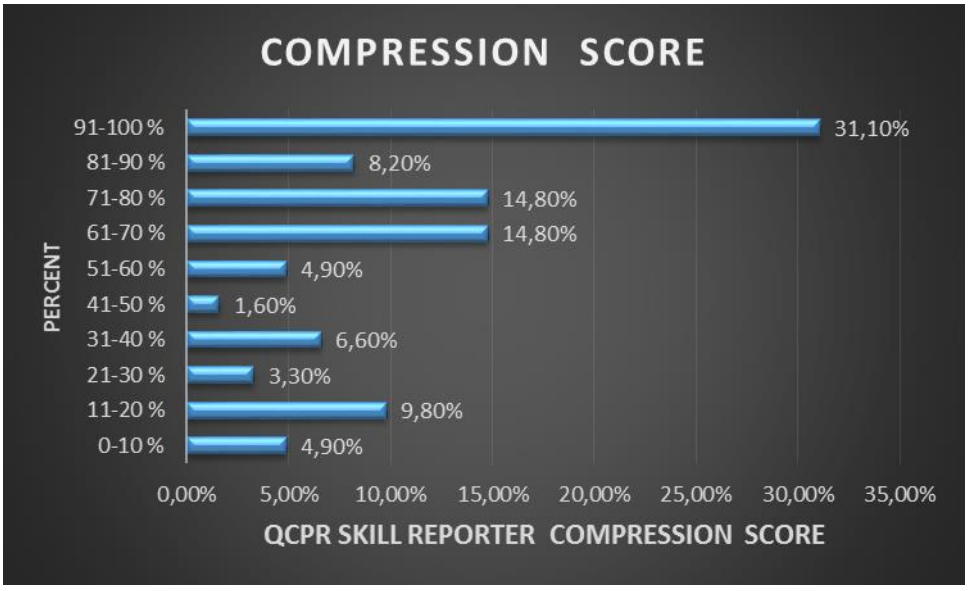

Figure 4: Compression Score

Ventilation score, according to Laerdal's software, ranges between 71-100, at 55.8% of the sample, while 19.7% have scored up to 50.

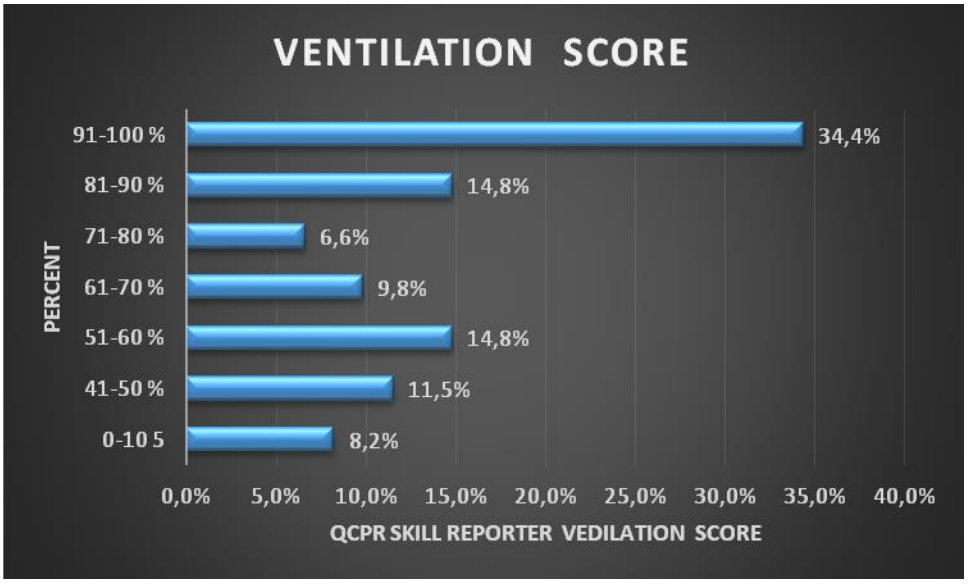

Figure 5: Ventilation Score

The majority of the sample, the 78.7% of the total chooses the center of the chest and thus the correct position for the placement of his/her hands during pectoral compressions, both as an initial choice, and during the Cardiovascular Resuscitation cycle. However, there is a smaller percentage of instructors, who, either do not choose the correct point of chest compression initially, or modify the compression point, by compressing at the wrong point during the application of the compression.

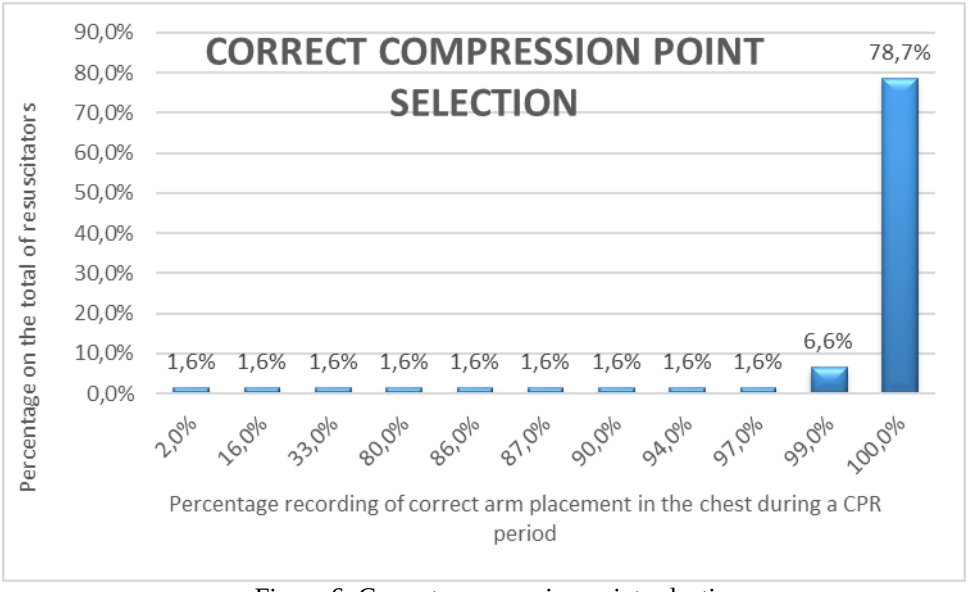

Figure 6: Correct compression point selection

Two additional basic parameters for correct chest compression are both the depth of the compressions, and the chest restoration to its original condition. In the first parameter, the target population managed to have an average depth of compression of 5-6 cm at 60.6%, 11.5% barely passed this limit of 6 cm and a fairly high percentage of 27.9% scored a mean depth of compression of 3-4.9 cm.

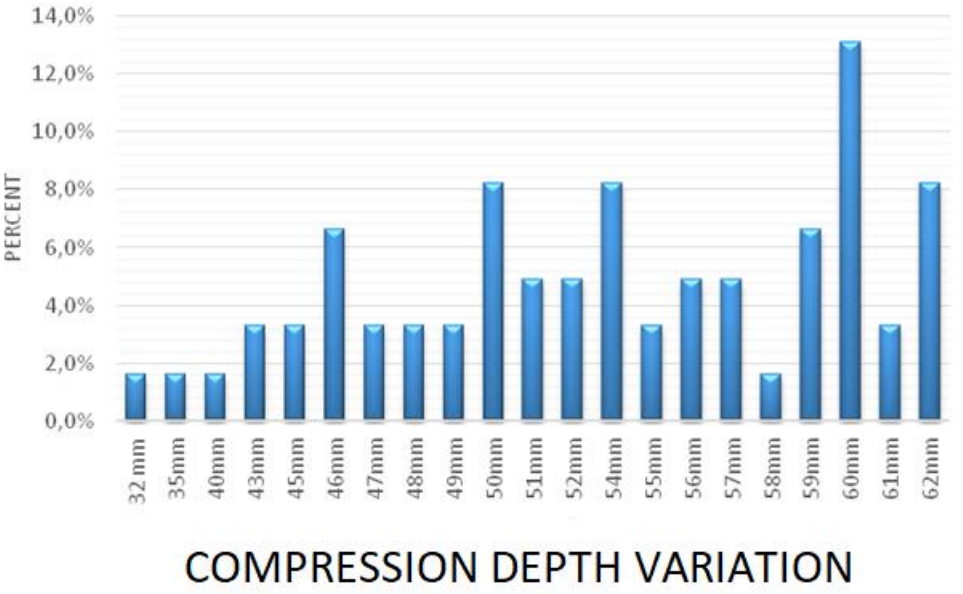

Figure 7: Compression depth variation

Regarding the chest restoration to the neutral position prior to the new compression, it is observed that the majority of the instructors are not allowing the thoracic cage to fully expand, at 50.5%, per 2 minutes of CPR, while a satisfactory expansion is only achieved at 13, 0% per CPR cycle.

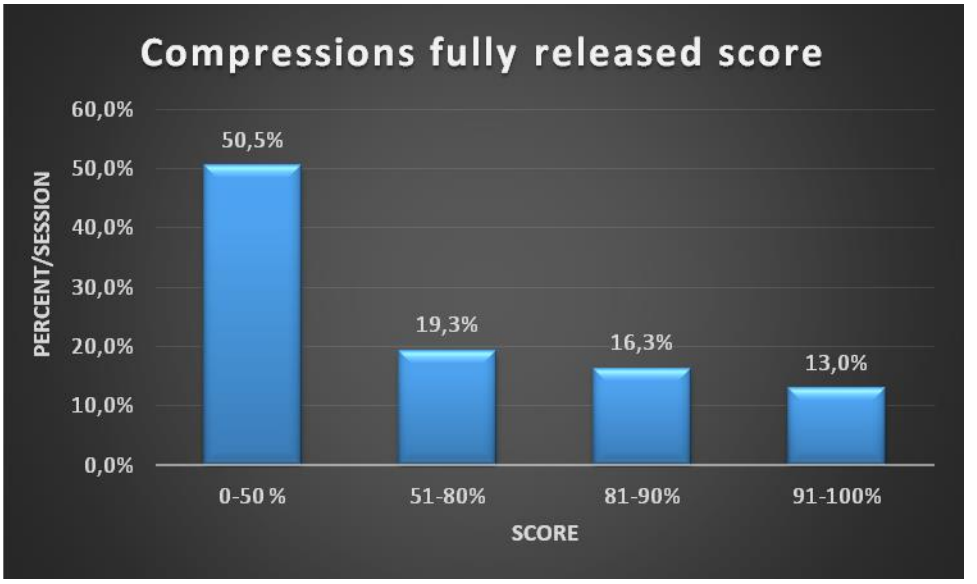

Figure 8: Compressions fully released score

Regarding the frequency of compressions, only 36.1% of the instructors score within the range of 100-120 compressions/ min, with most of them slightly exceeding this limit, the frequency being between 120-140 compressions/ min. Both low compression frequency, of 80-100 compressions/ min, and high one, above 160 compressions/ min, score a relatively small percentage of 3.3%.

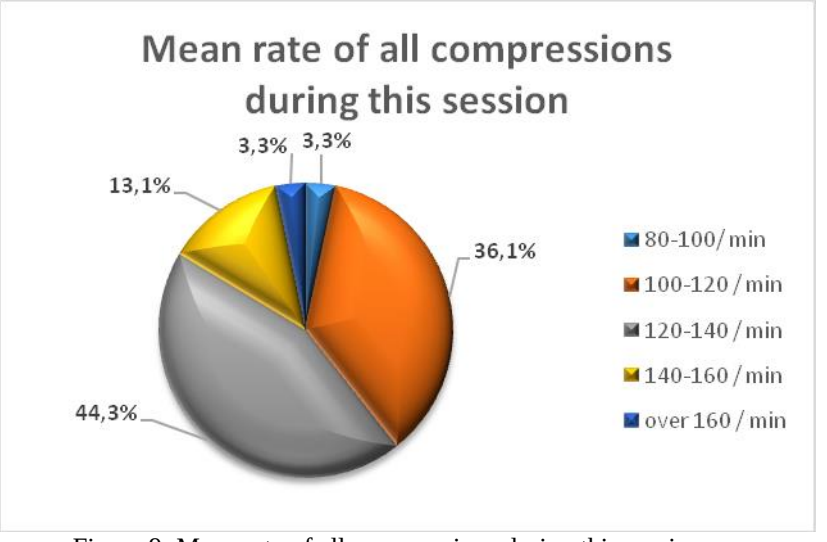

Figure 9: Mean rate of all compressions during this session

By looking at the parameters relating to the ventilations skill, 37.7% of the sample is observed to be giving ventilations with an average volume of air of 400-700ml, which is also indicated as an appropriate volume per ventilation. A high

percentage, ie. 50.8% of the sample, proceeds to ventilations with an air volume greater than or equal to that recommended, sometimes exceeding 1400 ml.

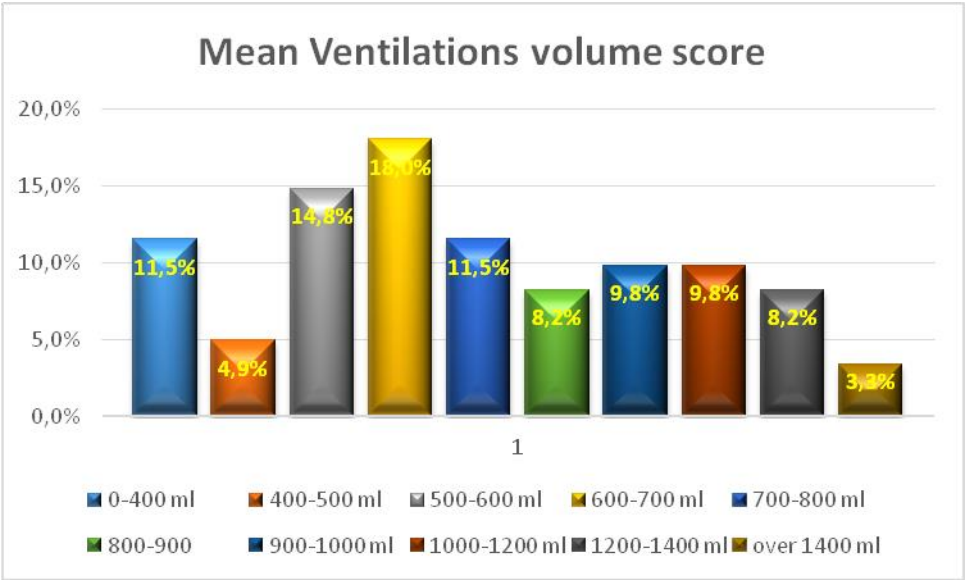

Figure 10: Mean Ventilations volume score

In the aforementioned research the analysis gives the following data: the majority of instructors (70.4%) give 5-6 ventilations/min, a frequency that is necessary for a successful Cardiopulmonary Resuscitation.

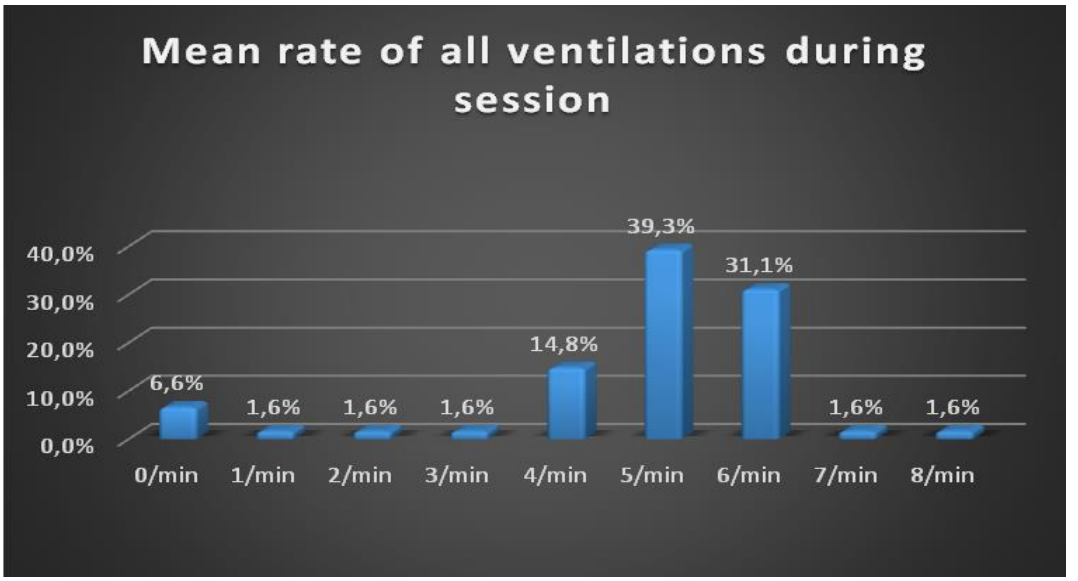

Figure 11: Mean rate of all ventilations during session

To analyze the results, a Pearson Correlation was conducted, which highlighted the following:

There is a statistically significant correlation of the educational level with the final score of the knowledge questions with P = 0.041 (P <0.05) and with a negative correlation (-0.261); that is, the higher the educational level, the lower the final score. There is also a correlation of the educational level with both the rescue ventilation score and the ventilation score with a sufficient volume of air with P = 0.023 and P = 0.042, respectively (P <0.05). In the individual skill indicators, although not statistically significant, nevertheless their correlation with the educational level is negative. Indicatively, the correlation between education/ training and the number of compressions (-0,188), the average compression depth (-0,098), and the average compression frequency (-0,077), are mentioned.

Working years, apart from their statistical significance regarding age and income, with P = 0.000 in both cases (P <0.05), also significantly affect the compression factor with a sufficient depth P = 0.036 (P <0.05). It is important that the final score of the knowledge questions follows the final skill score, with a statistical significance of P = 0.09 (P <0.01).

Table 1: Pearson Correlation analysis – Working years

		WORKING YEARS
AGE ABSOLUTE VALUE	Pearson Correlation	,877**
	P	,000
MONTHLY INCOME	Pearson Correlation	,686**
	P	,000
COMPRESSIONS WITH ADEQUATE DEPTH	Pearson Correlation	,288*
	P	,036

The final skill score appears to be significantly influenced by the following factors: compression score P = 0.00 (P <0.01), ventilation score P = 0.003 (P <0.01), percentage of time when compressions are administered P = 0.028, compressions by placing the hands at the correct point P = 0.001 (P <0.01), with the average compression depth P = 0.004 (P <0.01), compressions with full chest restoration P = 0.000 (P < compressions P = 0.000 (P <0.01). As for the percentage of compressions, this is significantly influenced by the correct positioning of the hands at the correct compression point P = 0.001 (P <0.01), the number of compressions P = 0.003 (P <0.01), the depth of compressions, as well as the compressions with full chest restoration, with P = 0.017 and P = 0.000, respectively (P<0.01), and the adequate frequency of the compressions P = 0.000 (P <0.01).

Table 2: Pearson Correlation analysis MCQ Score

		MCQ Score
EDUCATIONAL LEVEL	Pearson Correlation	-,261*
	P	,041
QCPR score, based on compressions, ventilations and the flow fraction ABSOLUTE VALUE	Pearson Correlation	,330**
	P	,009
QCPR score, based on compressions, ventilations and the flow fraction	Pearson Correlation	,308*
	P	,016
Ventilation score ABSOLUTE VALUE	Pearson Correlation	,305*
	P	,017
Ventilation score	Pearson Correlation	,289*
	P	,024
Time percentage, when compressions were administered.	Pearson Correlation	,280*
	P	,029
Mean time with no flow	Pearson Correlation	,254*
	P	,048

5 Discussion

Cardiopulmonary Resuscitation instructors are described as adult trainers, who should have some basic features according to Mocker & Noble, 1981 [30]. These features can be summarized in the following:

- Ability to communicate effectively with trainees/ learners.
- Ability to establish an effective relationship with trainees/ learners.
- Ability to strengthen their positive attitudes.
- Ability to create a climate encouraging participation

- Ability to create relationships of mutual respect between instructors and trainees
- Ability to adapt teaching to the characteristics of each trainee as well as to the characteristics of the training group [11].

These features make instructors capable of communicating their knowledge and skills. The question that arises and is being studied is, whether they, themselves, possess this knowledge and skills.

Many studies have been conducted over time, studies that measure resuscitators' knowledge and skills regarding CPR, utilizing various assessment methods, based essentially on the evaluation of knowledge, with the use questionnaires and skills and their subjective graduation by experienced instructors. The majority of studies conclude that education in Cardiopulmonary Resuscitation with conventional training methods has similar educational results [14-15]. Various studies suggest that practicing on feedback preforms improves performance and increases the effectiveness of education and CPR performance over time [17]. Even the introduction of Virtual Reality Mannequin (VREM) in simulation training has a very positive impact as assessed by CPR instructors, due to the realism it provides to education [18].

It is a fact that there are bibliographic references, which capture a significant percentage of trained resuscitators and instructors, applying CPR in the wrong way [12] [19-20]. A study, in which the CPR application by instructors was recorded on video, showed a significant percentage of deviation from the correct CPR implementation, according to the American Heart Association recommendations and guidelines regarding the rate and depth of compressions in Cardiopulmonary Resuscitation [21]. A study conducted to evaluate the CPR by using an active preform from instructors, highlighted the existence of a high percentage of errors [22]. Similar results are presented in this study, with errors being observed and recorded by the software, during CPR performance by the instructors. CPR instructors' difficulty was also observed in a study that concerned the design of the depth of compressions on plain paper [23]. In the present study, nearly one-third of the sample does not reach the minimum 5 cm threshold defined as the minimum compression depth by the ERC guidelines.

In many cases, even CPR instructors themselves feel inadequate to prepare candidate resuscitators, and feel the need for retraining [12]. A factor in maintaining and improving knowledge and skills on CPR performance has been shown to be time, because, as the years pass by, CPR knowledge improves. Age, of course, was identified as an unfavorable factor in maintaining skill, while the upper educational level seemed to have a positive effect. As far as the preservation of knowledge is concerned, the higher education level has been associated with higher scores [24].

This may also justify the fact that there is a wide discrepancy in the visual evaluation of the effectiveness of chest compressions between accredited evaluators, which ultimately casts doubt on the reliability and value of this evaluation method and makes it more accurate and reliable to use preforms with electronic recording of the results [22; 25]. The above researches justify the results of the present study, since we observe that the higher educational level does not necessarily mean better skill outcomes, and there is the paradox of a statistical significance, in reverse order, of the level of education and skill and knowledge score. These results contradict the above-mentioned surveys. A possible explanation may be the high frequency of participation of the sample in educational programs, which may be justified by the lower educational level which may give the participants more free time to engage in the educational process. Another important factor in the proper administration of CPR may be the work experience and the type of profession they practice. Age does not seem to have any statistically significant effect, with respect to the skills or knowledge that instructors possess in this research.

Technology is an indispensable tool for assessing skills as defined by the ERC guidelines, and it is necessary to obtain feedback to establish the instructor's harmonization with them [26]. It is clear from the results been captured in the present research, that the use of technology and the recording of data through software is a key tool for determining the successful performance of skills according to the ERC guidelines..

Finally, it is evident that training with the use of electronic preforms and the relative software results in better training and more objective assessment of learners/ trainees, while, at the same time, providing the opportunity for the retraining and objective evaluation of instructors. The use of these educational tools has a positive impact on instructors, due to the realism it provides to Cardiopulmonary Resuscitation education/ training, at all levels [18].

6 Conclusions

Training with the use of preforms, along with appropriate software, results in the objective recording of skills, making it possible to identify errors in real time. Cardiorespiratory Resuscitation instructors should, in addition to the characteristics that all adult instructors/trainers should possess, be re-educated and evaluated at regular intervals. Both age and educational level do not seem to affect the ability of someone, to become a Cardiopulmonary Resuscitation instructor. The use of such preforms can be a necessary tool in evaluating candidate trainers/ instructors, who will need to achieve specific percentages during their skills rating, to be characterized as competent instructors.

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