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Complete List of Authors:	Oteir, Alaa O.; Jordan University of Science and Technology, Allied Medical Sciences; Monash University, Community Emergency Health and Paramedic Practice Almhdawi, Khader; Jordan University of Science and Technology, Rehabilitation Sciences Kanaan, Saddam ; Jordan University of Science and Technology, Rehabilitation Sciences Alwidyan, Mahmoud ; Jordan University of Science and Technology, Allied Medical Sciences Williams, Brett; Monash University, Community Emergency Health and Paramedic Practice
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Alaa O. Oteir, PhD[1,2]; **Khader Almhdawi**[3], PhD; **Saddam F. Kanaan**[3], PhD; **Mahmoud T. Alwidyan**, PhD[1]; **Brett Williams**[2], PhD

1. Paramedicine Program, Department of Allied Medical Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan
2. Department of Community Emergency Health and Paramedic Practice, Monash University, Melbourne, Victoria, Australia
3. Department of Rehabilitation Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan

Email:

Alaa O. Oteir: aooteir@just.edu.jo **(corresponding author)**

Khader Almhdawi: khader@just.edu.jo

Saddam F. Kanaan: sfkanaan@just.edu.jo

Mahmoud Alwidyan: mtalwidyan@just.edu.jo

Brett Williams: Brett.williams@monash.edu

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Correspondence:

Alaa O. Oteir
Department of Allied Medical Sciences
Faculty of applied medical sciences
Jordan University of Science and Technolgy
BO.Box 3030
Irbid, 22110
Jordan
ORCID: 0000-0002-3156-2773
E-mail: aooteir@just.edu.jo

ABSTRACT

Objective: To explore the level of cardiopulmonary resuscitation (CPR) knowledge among Allied Health Professions (AHP) students and its associated factors.

Methods: This is a cross-sectional study assessing CPR knowledge among AHP students. A multidisciplinary expert panel designed a survey, which then was piloted to 20 potential participants. The survey had two sections including demographics and knowledge questions. Knowledge questions scores ranged from zero to ten, where ten indicates all questions were answered correctly.

Results: Data were collected from 917 students, 883 (96.3%) students had complete surveys and were included in the study. The median age was 21 years [First quartile (Q1) - Thirds Quartiles (Q3): 20-22] and the majority (72.86%) were females. Only 190 (21.5%) students had previous CPR training with the top barriers in receiving CPR training were unawareness of training opportunities and a lack of time. Participants had a median CPR knowledge score of four (Q1-Q3: 3-5) out of ten maximum potential points. Trained individuals had a higher median score compared to the untrained (5 [4-6] vs. 4 [3-5] points, $p<0.001$). Previous training was the only factor to be independently associated with higher knowledge (Adjusted $\beta = 0.87$; $p<0.001$), with higher scores being associated with more recent training (<1 year).

Conclusion: There is poor knowledge of CPR among AHP students. However, higher knowledge scores were associated with previous CPR training and more recent training. Top reported barriers in obtaining CPR training were unawareness of training locations and lack of time. Compulsory training courses, shorter training periods as well as recurrent and regular refreshing courses and use of various media devices are recommended.

Keywords: cardiopulmonary resuscitation; CPR; knowledge, Allied health professions

Strengths and limitations

- there is the first study assessing CPR knowledge among allied health profession (AHP) students in Jordan
- A multidisciplinary expert panel designed a survey which was piloted to 20 potential participants.
- The results of this study will provide as a baseline for future research regarding CPR among AHP professionals in Jordan.
- Our study provides recommendations to increase the awareness of CPR. And to overcome the barriers reported by the participating students
- The inherent nature of the cross-sectional design of this study and recall bias of CPR training may have affected reporting the association with knowledge.

INTRODUCTION

Cardiac arrest is a major healthcare problem with poor survival rates. Early cardiopulmonary resuscitation (CPR), including bystander CPR, is significantly associated with improved survival to hospital discharge rates from out-of-hospital cardiac arrest (OHCA). [1-3] It is also a crucial element in the chain of survival in OHCA. [1 2 4] Therefore, training of large numbers of people continues to be a priority goal for the American Heart Association (AHA) and Red Cross/crescent organisations around the world. [5]

Reports indicated that the Middle-East populations are increasing significantly over upcoming decades, including Jordan. [6] With expected longevity, there will be an increasing incidence of chronic diseases such as cardiovascular and neurological disorders.[7] This may increase the risk of various cardiovascular emergencies, which stresses the importance and need of CPR knowledge and skills by all community members. Moreover, a small study in Northern Jordan reported that only 3% of 79 OHCA patients survived, with CPR initiated for only 22% of this cohort, explaining this by the lack of CPR knowledge and skills. [8]

Allied health care professionals and students deal with many patients on daily basis, during their work or clinical training; hence, they are expected, and often have to attend life-threating emergencies including cardiac arrests. Furthermore, international studies also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] Therefore, trained professionals or students may be able to perform early CPR, initiate resuscitation efforts and speed up the access to prehospital and definitive care. This may lead to increasing survival rates and improving patient outcomes.[11-16] In addition, studies concluded that basic and advanced life support skills deteriorate after only six months post

training. [12 13 17] Therefore, it is important to continuously refresh trainees knowledge and skills on regular basis.

There is a paucity of research regarding CPR knowledge in Jordan in general. Therefore, as a first step, this study explores the level of knowledge among AHP students and possible factors that contribute to their knowledge. This line of research is highly needed to establish effective strategies for improving CPR knowledge and skills. The study will also provide a baseline for future research regarding CPR among AHP professionals in Jordan.

Methods

Design and setting:

This is a cross-sectional study assessing CPR knowledge among AHP students in the Faculty of Applied Medical Science (FAMS). FAMS is a relatively newly established comprehensive allied health sciences faculty at Jordan University of Science and Technology (JUST) with nine undergraduate programs: medical laboratory sciences, physical therapy, occupational therapy, speech pathology, dental technology, allied dental science, radiologic technology, optometry, and paramedicine. A multidisciplinary expert panel including paramedicine, physical therapy, and occupational therapy academics designed and assessed the questionnaire for face and content validity. A second group of four paramedicine graduates also evaluated the survey providing feedback that further improved the validity of the survey. The study survey was primarily designed based on the 2015 American Heart Association recommendations for laypersons CPR training as well as the relevant literature.[1-4] The survey (in Arabic language) was then piloted with a group of 20 AHP students and five paramedicine professionals to further evaluate its validity. Following this, the survey was updated based on

students and professionals feedback. Main changes included changing one knowledge question answers to give more clarity and modifying the wording of two other questions to improve readability. The expert panel approved the final version.

The survey was paper-based, anonymous and included two sections: the demographics section (section 1) included participants' demographic, university level (which year in the program), university cumulative grade point average (GPA), the status of previous CPR training, motivators and barriers to learning CPR. The knowledge section (section 2) included ten questions that evaluated the knowledge about performing CPR and a question about the emergency phone number in Jordan. Nine of these questions had four different potential answers with only one correct answer, while one question was a true/false question. The scores of the questionnaire range from zero to ten, where ten indicates all questions were answered correctly. The study survey is demonstrated in Table 2.

Sample and setting

A convenient sample consisting of second, third, and fourth-year AHP university students were asked to voluntarily participate in the study. The FAMS offers four-year Bachelor of Science programs of nine AHP majors. Of these, we approached eight majors including medical laboratory sciences, physical therapy, occupational therapy and speech pathology, dental technology, allied dental science, radiologic technology, and optometry. [18]

The corresponding author (AO) and research assistants recruited student participants, explained its purposes and collected surveys upon completion. A sample size larger than 500 participants is considered excellent in cross-sectional studies.[19] Furthermore, participants who were in their first year and those included in the pilot study were excluded. First-year

students were excluded as they can change their admissions, after their first year, to programs other than AHP. All participants in this study signed IRB informed consent forms and received no compensation for their participation.

Statistical analysis

Continuous variables were reported as median and interquartile ranges. Participants were categorised as trained if they have received any CPR training, whereas untrained individuals were students who never had any CPR training. Comparisons between trained and untrained groups performed using Mann-Whitney U tests or student's t-test, as appropriate. Categorical data were presented as counts and proportions and the difference between trained and untrained groups was compared using chi-square tests. Associations with student knowledge (maximum potential score of 10 points) were examined using univariate linear regression analyses. Furthermore, to identify the variables independently associated with CPR knowledge ($p<0.1$), a multivariate regression model with stepwise backward elimination was used. In all regression analyses, a p-value of 0.05 was specified for addition to the model, whereas we specified $p > 0.1$ for removal from the model. All statistical analysis was undertaken using STATA (version 14.0 Stata Corporation, College Station, TX, USA)

Ethical approval

Jordan University of Science and Technology Institutional Review Board approved the study (project number: 24/112/2018)

RESULTS

Descriptive analyses

The FAMS at JUST included 1,525 students of the second, third and fourth year. Data were collected in April 2018 with 917 (60.1% of the total population) students responding to the survey, however, 883 (response rate of 96.3%) students had completed the survey successfully and were included in the final analysis.

Table 1 includes descriptive statistics of students as well as a comparison between those who had prior CPR training versus those who never had any CPR training. The median age of participants was 21 years (Q1-Q2: 20-22) with the majority (72.86%) being females. There was no statistically significant difference in CPR knowledge between males and females (p=0.3). However, a statistically significant difference was observed between trained and untrained groups (p<0.001). Therefore, comparisons herein were based on the training.

Only 190 (21.5%) students had previous CPR training. Trained participants were older than untrained individuals were (21 years (Q1-Q2: 21-22) versus 21 years (Q1-Q2: 20-21) years, p<0.001). The higher the study year, the higher the proportion of trained individuals (p<0.001). Furthermore, no significant statistical difference was observed between males and females in the training groups (p=0.12).

Table 1 Participants demographics with a comparison between CPR trained vs untrained participants

Characteristic	Total N (%)	Trained N= 190 (%)	Untrained N=693 (%)	*P**
Age (median years, [Q1 – Q3])	21 [20-22]	21 [21-22]	21 [20-21]	<0.001
Sex				
Male	238 (27)	49 (25.8)	189 (27.8)	0.68
Female	645 (73)	141 (74.2)	504 (72.2)	
Year of study				
Second	315 (35.7)	35 (18.4)	280 (40.4)	<0.001
Third	338 (38.3)	74 (38.9)	264 (38.1)	
Fourth	230 (26.0)	81 (42.6)	149 (21.5)	
Having a family member with cardiac diseases				
Yes	269 (29.45)	58 (30.5)	202 (29.1)	0.7
No	648 (70.55)	132 (69.5)	491(70.9)	

*Student t-test or chi-squared tests; SD: Standard Deviation; Q1 – Q3: first and third Quartiles

The majority of trained students were trained at the university (57.9%), followed by schools (17.9%), private work or non-governmental organisations (16.8%) and self-learning/private centres (7.4%). Motivations for CPR training included personal interest (44.4%), compulsory requirements (40.6%), and helping other people and having family members with heart diseases (15%).

Figure 1 includes the top five barriers that participants indicated for their inability to take/retake the CPR training. Top causes were unknown training locations (33%) and the lack of time (32.1%).

The majority of participants (68.9%) indicated that they were willing to enrol in CPR training (or retraining). Helping people (43.7%) and personal interest (41.9%) were the top two motivators to learn or retrain in CPR (figure 2).

Table 2 summarises the knowledge questions and their correct answers comparing trained and untrained students. The scores ranged from zero to nine out of ten maximum potential

points, with a median score of 4 (Q1-Q3: 3-5). The trained group had a higher median score compared to the untrained group (4 [3-5] vs. 2 [2-4], p<0.001).

Table 2 Comparing survey answers: trained vs untrained in CPR

Knowledge questions	Total N=883 (%)	Trained N= 190(%)	Untrained N=693(%)	P*
Total knowledge score regarding CPR [median, Q1-Q3]	4 [3-5]	5[4-6]	4 [3-5]	<0.001
1. You were alone and sighted an adult laying on the floor, what would be the most important step to do?				
Check consciousness and breathing	351 (39.75)	91 (47.9)	260 (37.5)	0.01
Incorrect answers	532 (60.25)	99 (52.1)	433 (62.5)	
2. Which of the following is true regarding CPR?				
CPR Starts with chest compressions	467 (52.9)	121(63.7)	346 (49.9)	0.001
Incorrect answers	416 (47.1)	69 (36.3)	347 (50.1)	
3. What is the compressions to breathing ratio for an adult patient?				
30:2 (compressions: breaths)	327 (37)	111 (58.4)	216 (31.2)	<0.001
Incorrect answers	556 (63)	79 (41.6)	477 (68.8)	
4. Which of the following is a characteristic of true effective CPR?				
Allowing full chest recoil	392 (44.4)	125 (65.7)	267 (38.5)	<0.001
Incorrect answers	491 (55.6)	65 (34.3)	426 (61.5)	
5. What is the number of compressions per minute for an adult patient?				
100-120 compressions/minute	90 (11.2)	20 (10.5)	70 (10.1)	0.86
Incorrect answers	793 (89.8)	170 (89.5)	623 (89.9)	
6. What is the depth of compression for an adult patient?				
5 to 6 cm	152 (17.2)	31 (17.2)	121 (17.5)	0.71
Incorrect answers	731 (82.8)	159 (82.8)	572 (82.5)	
7. Once confirmed the need for CPR, chest compressions should start within				
10 seconds	290 (32.9)	62 (32.6)	228 (32.9)	0.94
Incorrect answers	593 (67.1)	128 (67.4)	465 (67.1)	
8. Which of the following is a characteristic of true effective CPR?				
Pushing hard and fast	267 (31.3)	60 (31.6)	207 (29.9)	0.65
Incorrect answers	616 (69.7)	130 (68.4)	486 (70.1)	
9. **Emergency Number**				
911 (correct)	706 (79.95)	161 (84.7)	545 (78.6)	0.063
Other numbers (000, 112, 199)	177 (20.05)	29 (15.3)	148 (21.4)	
10. Sudden loss of consciousness/collapse may indicate a need for CPR.				
Yes (correct)	436 (49.3)	96 (50.5)	340 (49.1)	0.72
No	447 (50.7)	94 (49.5)	353 (50.9)	

*Mann-Whitney test or chi-squared tests; Q1 – Q3: first and third Quartiles; CPR: cardiopulmonary resuscitation

Furthermore, the knowledge score ranged between one to nine among trained individuals, with 108 students (56.8%) scoring five or more points. Also, when asked about the last time of training 33% had their training recently (< one year), 24.3% past two years, 27.6% in the past three to four years and 15.1% more than five years ago.

Regression analysis

Factors significantly associated with higher knowledge scores were previous CPR training (β =0.87; 95%CI: 0.61, 1.1; p<0.001), age (β = 0.07; 95%CI: 0.015, 0.13; p=0.013) and higher study level (β =0.4; 95% CI: 0.18, 0.67; p=0.001). Having a family member with cardiac disease was not statistically significant (β = 0.2; 95% CI: -0.3 0.45; p=0.085). Using a stepwise multiple regression analysis with backward elimination, only previous training remained statistically significant (Adjusted β = 0.87; 95% CI: 0.6, 1.13 p<0.001). Factors included in the model were previous training, age, sex, level of study, nationality, student GPA and having a family member with cardiac disease.

Table 3 Linear regression analyses of factors associated with CPR knowledge

Knowledge of CPR	Univariate regression			Multivariate regression		
	β	P	95% CI	β	P	95% CI
CPR Trained	0.87	<0.001	0.61,1.1	0.87	<0.001	0.6,1.13
Family history of cardiac disease	0.21	0.085	-0.03,0.45	0.2	0.085	-0.03,0.4
level						
2nd year	Ref					
3rd year	0.20	0.17	-0.08,0.4	-	-	-
4th Year	0.35	0.015	0.07,0.64	-	-	-
Age	0.075	0.032	0.006,0.14	-	-	-
Females	0.13	0.29	-0.11,0.38	-	-	-
Nationality (Locals)	-0.11	0.45	-0.4,4.3	-	-	-
GPA	0.14	0.2	-0.078,0.37	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average; Nationality: Jordanian; constant value for the multivariate model =3.7

Furthermore, table 4 outlines the univariate and multivariate analyses examining the factors associated with knowledge among trained individuals. Time since last training was the only factor to be associated with CPR knowledge in both analyses. Compared to recent training (< one year), longer times since last training were negatively associated with the knowledge scores. Multivariate analysis was adjusted for study level, nationality, having a family member with cardiac disease, age, sex, and GPA.

Table 4: Linear Regression analyses of factors associated with knowledge scores among trained individuals

Knowledge of CPR	**Univariate regression**			**Multivariate regression**		
	β	**P**	**95% CI**	**β**	**P**	**95% CI**
Time since last training						
Recent (<1 year)	Ref	-	-	Ref	-	-
Two years ago	-0.76	0.011	-1.3, -0.18	-0.8	0.006	-1.4, -0.2
Three to four years ago	-1.05	<0.001	-1.6, -0.49	-1.1	<0.001	-1.7, -0.5
>five years	-1.9	<0.001	-2.6, -1.2	-1.9	<0.001	-2.6, -1.2
Family history of cardiac disease	0.12	06	-0.4, 0.6			
level						
2nd year	Ref					
3rd year	0.6	0.07	-0.06, 1.26	-	-	-
4th Year	0.6	0.053	-0.01, 1.29	-	-	-
Age	0.12	0.1	-0.04, 0.28	0.14	0.066	-0.01, 0.3
Females	0.2	0.4	-0.3, 0.77	-	-	-
Nationality (Locals)	0.2	0.47	-0.4,4.3	-	-	-
GPA	0.35	0.13	-0.1,0.8	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average; Nationality: Jordanian; constant value for the multivariate model =2.36

DISCUSSION

Our study shows a poor level of CPR knowledge among AHP students; while trained students had a higher knowledge of CPR compared to students who did not have previous CPR training. Moreover, previous training was the only factor to be associated with higher knowledge score. Moreover, among trained individuals, times since last training was the only factor to be associated with trained individual level of knowledge.

The majority of participants who did not receive CPR training reported unawareness of training locations and the lack of time as the top barriers. Nevertheless, the majority of participants were willing to be enrolled or repeat CPR training, motivated by their willingness to help people in need and having a personal interest in learning CPR skills.

Our results are similar to other studies reporting higher knowledge among trained individuals, despite the poor level of knowledge. [20-23] Aroor et al., reported a mean knowledge score of 4.16 (SD± 1.40) of a 10 maximum score among nursing, dental, and medical individuals including undergraduate, internship, and postgraduate groups. However, the authors found that age, gender, level of training, course of study and previous exposure to basic life support (BLS) were significantly associated with knowledge level ($P < 0.05$). [21] While our regression analysis accounted for these factors, only CPR training was associated with better knowledge. Barriers to learning CPR, in the Aroor et al study, was similar to the top reported barriers in our study being lack of time and unawareness of where these workshops are held. [21]

Furthermore, a study in Pakistan including 250 medical students also reported that medical student with BLS training had higher knowledge compared to those untrained (47% correct answers vs 39% incorrect answers). [20] Moreover, Ghanem et al examined the knowledge of CPR among 823 medical university students reporting 27% of participants who received BLS

training. The study also reported similar results where CPR knowledge was associated with previous CPR training ($p<0.001$), despite their overall poor level of knowledge. The majority of participants were males (88.3% of 824) which is different from our cohort. In addition, despite the low percentage of female participants, the study reported higher knowledge scores among females ($p < 0.001$). [22]

Other international studies have also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] This may reflect that higher knowledge of CPR is associated with previous training. Although our study was not a cohort study, our results are in concurrence with other studies reporting that BLS skills deteriorate with time post education and training. [12 13 17]

Furthermore, it is alarming that, despite about one-third of the participants reported having family members with a cardiac history, the high percentage of the unsatisfactory level of knowledge as well as the willingness to learn CPR should urge designing compulsory and regular training programs/courses or graduation requirements. This is arguably especially important for medical and health care majors which are supported in recommendations made in numerous reports. [3 20 21 23] Such programs can teach hands-only/compressions only CPR, which is highly recommended by the American Heart Association[4] and was reported to be associated with participants being more willing to perform CPR and higher survival rates.[2]

To overcome the barriers to taking a CPR course, short training workshops (<30 minutes) can also be designed. [24] This can be combined by introducing media, mobile devices, and self-learning videos to expand the number of potential participants who are willing to learn CPR. [5 25] Furthermore, Arabic versions of CPR can be developed and validated for the public in

Arabic speaking countries, so students and healthcare professionals can help training larger numbers of the population at life-threating risks.

The unsatisfactory level of knowledge found in our study may indicate an inadequate knowledge level among professionals who interact with patients on a daily bases. Further studies are also recommended to examine the professional knowledge and attitude towards CPR in Jordan as well as skill and knowledge retention.

Limitations

The inherent nature of the cross-sectional design of this study and recall bias of CPR training may have affected reporting the association with knowledge. There is no standardised published survey regarding CPR knowledge; however, we adopted our questionnaire based on the AHA 2015 recommendations as well as the relevant literature regarding CPR. Moreover, an expert panel designed and reviewed the survey from paramedicine and other allied health science fields. The survey was also piloted to 20 AHP students and modified based on their feedback in an attempt to improve validity and reliability.

There is a paucity of research regarding CPR knowledge among AHP students in general. However, we compared our results to studies including university students with health-related majors including medicine, nursing and any allied health professions, which considered to be comparable to our cohort due to similar study designs and level of questions.

Generalising the findings of our results should consider the inclusion criteria, type of questions, setting, type of participants and the type of outcome measures used in this study.

CONCLUSION

There is an unsatisfactory knowledge of CPR among AHP students in Jordan. However, higher knowledge scores were associated with previous CPR training as well as more recent training. The study also found that top barrier were unawareness of training locations and lack of time. Finally, compulsory training courses, shorter training periods, and use of various media devices are recommended to reach wider communities.

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CONFLICT OF INTEREST: The authors declare no conflict of interest.

Contribution statement: Dr. Alaa Oteir (AO), conceived the study idea, collected the data , conducted the statistical analyses and drafted the manuscript. AO, Dr. Khader Almahdawai (KA), Dr. Saddam Kanaan (SK), Dr. Mahmoud Alwidyan (MA) and Prof. Brett Williams (BB), have made a considerable contribution to the study design, interpretation, writing and reviewing the manuscript. The final manuscript has been approved by all authors.

Figures

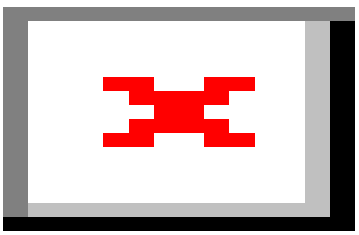

Figure 1 Barriers to CPR training (n=722)

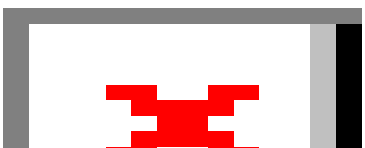

Figure 2 Motivators for CPR training when it becomes available (n=689; not mutually exclusive)

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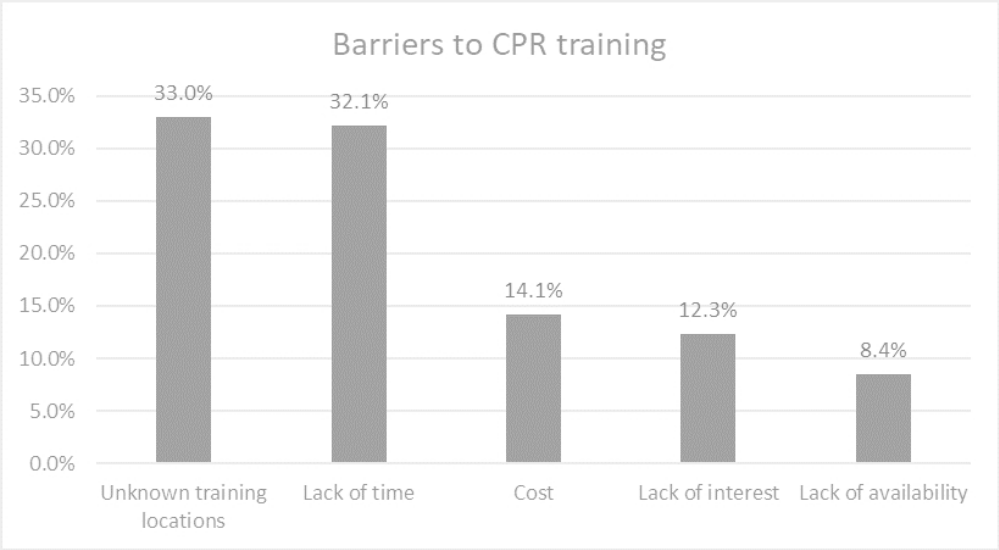

Figure 1 Barriers to CPR training (n=722)

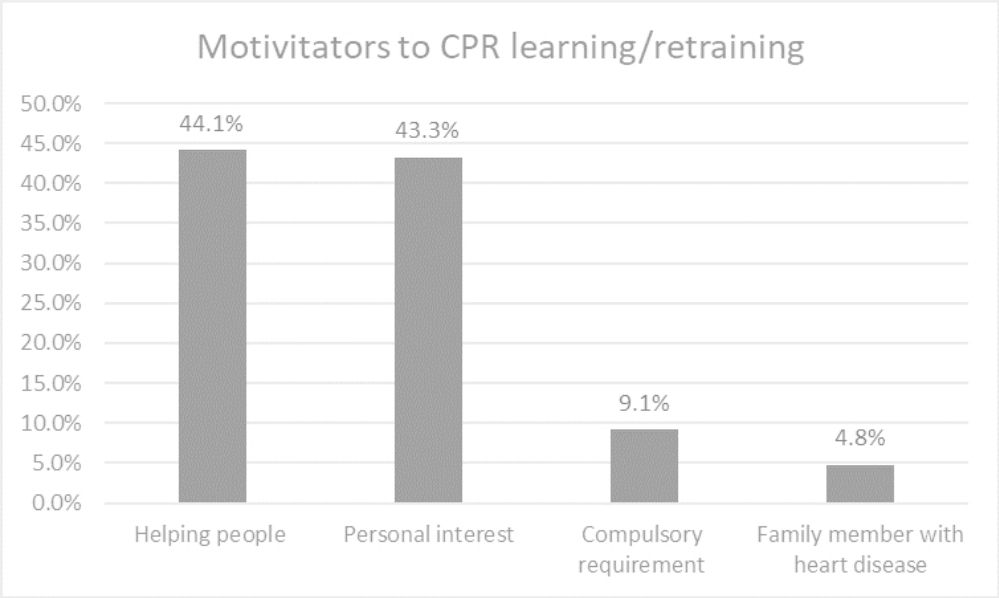

Figure 2 Motivators for CPR training when it becomes available (n=689; not mutually exclusive)

Title: CPR level of knowledge among allied health university students

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	2, 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6,7*
Bias	9	Describe any efforts to address potential sources of bias	*6,7*
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9, 10
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	9-12

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,12
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

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Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

Alaa O. Oteir, PhD[1,2]; **Khader Almhdawi**, PhD[3]; **Saddam F. Kanaan**, PhD[3]; **Mahmoud T. Alwidyan**, PhD[1]; **Brett Williams**, PhD[2]

1. Paramedicine Program, Department of Allied Medical Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan
2. Department of Community Emergency Health and Paramedic Practice, Monash University, Melbourne, Victoria, Australia
3. Department of Rehabilitation Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan

Email:

Alaa O. Oteir: aooteir@just.edu.jo **(corresponding author)**

Khader Almhdawi: khader@just.edu.jo

Saddam F. Kanaan: sfkanaan@just.edu.jo

Mahmoud Alwidyan: mtalwidyan@just.edu.jo

Brett Williams: Brett.williams@monash.edu

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Correspondence:

Alaa O. Oteir
Department of Allied Medical Sciences
Faculty of applied medical sciences
Jordan University of Science and Technolgy
B.O. Box 3030
Irbid, 22110
Jordan
ORCID: 0000-0002-3156-2773
E-mail: aooteir@just.edu.jo

ABSTRACT

Objective: To explore the level of cardiopulmonary resuscitation (CPR) knowledge among Allied Health Professions (AHP) students and its associated factors.

Methods: This is a cross-sectional study assessing CPR knowledge among AHP students. A multidisciplinary expert panel designed a survey, which then was piloted to 20 potential participants. The survey had two sections including demographics and knowledge questions. Knowledge questions scores ranged from zero to ten, where ten indicates all questions were answered correctly.

Results: A total of 883 students had complete the surveys and were included in the study. The mean age was 21 years (±1.6) and the majority were females (73.05%). A total of 693 (78.5%) students did not receive previous CPR training and the top barriers to receiving CPR training were unawareness of training opportunities and a lack of time. Participants had a mean CPR knowledge score of 3.9 (±1.67) out of ten maximum potential points. Trained participants had a higher mean score compared to the untrained (4.6 (±1.67) vs. 3.75 (±1.6), p<0.001). Previous training (Adjusted β = 0.87; 95% CI: 0.6, 1.13; p<0.001) and being in the physical therapy program (Adjusted β = 0.46; 95% CI: 0.1, 0.8; p=0.009) were associated with higher knowledge. **Conclusion**: There is poor knowledge of CPR among AHP students including trained individuals. Efforts to increase the awareness of CPR should target students and professionals who are highly likely to encounter patient requiring CPR. Compulsory training courses, shorter training periods as well as recurrent and regular refreshing courses and use of various media devices are recommended.

Keywords: cardiopulmonary resuscitation; CPR; knowledge, Allied health professions

Strengths and limitations

- This is the first and largest study assessing CPR knowledge among allied health profession (AHP) students in Jordan
- The results of this study will provide a baseline for future research regarding CPR among AHP professionals in Jordan.
- Our study findings and recommendations can influence strategies to improve CPR knowledge and willingness to deliver CPR in Jordan and the MENA region
- There is no standardised or validated CPR survey. However, a multidisciplinary expert panel designed a survey which was piloted to 20 potential participants.
- The inherent nature of the cross-sectional design of this study and recall bias of CPR training may have affected reporting the association with knowledge.

INTRODUCTION

Cardiac arrest is a major healthcare problem with poor survival rates. Early cardiopulmonary resuscitation (CPR), including bystander CPR, is significantly associated with improved survival to hospital discharge rates from out-of-hospital cardiac arrest (OHCA). [1-3] It is also a crucial element in the chain of survival in OHCA. [1 2 4] Therefore, training of large numbers of people continues to be a priority goal for the American Heart Association (AHA) and Red Cross/crescent organisations around the world. [5]

Reports indicated that the Middle-East populations are increasing significantly over upcoming decades, including Jordan. [6] With expected longevity, there will be an increasing incidence of chronic diseases such as cardiovascular.[7] Moreover, a small study in Northern Jordan reported that only 3% of 79 OHCA patients survived, explaining this by the lack of CPR knowledge and skills. [8] Furthermore, allied health care professionals and students are expected, and often have to attend life-threating emergencies including cardiac arrests. Furthermore, international studies also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] Therefore, trained professionals or students may be able to perform early CPR, initiate resuscitation efforts and speed up the access to prehospital and definitive care. This may lead to increasing survival rates and improving patient outcomes.[11-16] In addition, studies concluded that basic and advanced life support skills deteriorate after only six months post training. [12 13 17] Therefore, it is important to continuously refresh trainees knowledge and skills on a regular basis.

There is a paucity of research regarding CPR knowledge in Jordan in general. Therefore, as a first step, this study explores the level of knowledge among AHP students and possible factors that contribute to their knowledge. This line of research is highly needed to establish effective

strategies for improving CPR knowledge and skills in Jordan including Jordanian universities. The study will also provide a baseline for future research regarding CPR knowledge and training among AHP professionals in Jordan. These effective strategies and future research may provide a model that can be adopted within Jordan as well as in the Middle East and North Africa (MENA) region.

Methods

Design and setting:

This is a cross-sectional study assessing CPR knowledge among AHP students in the Faculty of Applied Medical Science (FAMS). FAMS is a relatively newly established comprehensive allied health sciences faculty at Jordan University of Science and Technology (JUST) with nine undergraduate programs: medical laboratory sciences, physical therapy, occupational therapy, speech pathology, dental technology, allied dental science, radiologic technology, optometry, and paramedicine. A multidisciplinary expert panel including paramedicine, physical therapy, and occupational therapy academics designed and assessed the questionnaire for face and content validity. A second group of four paramedicine graduates also evaluated the survey providing feedback that further improved the validity of the survey. The study survey was primarily designed based on the 2015 American Heart Association recommendations for laypersons CPR training as well as the relevant literature (Survey questions and potential answers are provided in Appendix A).[1-4] The survey (in the Arabic language) was then piloted with a group of 20 AHP students and five paramedicine professionals to further evaluate its validity. Following this, the survey was updated based on students and professionals' feedback. Main changes included changing one knowledge

question answers to give more clarity and modifying the wording of two other questions to improve readability. The expert panel approved the final version.

The survey was paper-based, anonymous and included two sections: the demographics section (section 1) included participants' demographic, university level (which year in the program), university cumulative grade point average (GPA), the status of previous CPR training, motivators and barriers to learning CPR. The knowledge section (section 2) included ten questions that evaluated the knowledge about performing CPR and a question about the emergency phone number in Jordan. Nine of these questions had four different potential answers with only one correct answer, while one question was a true/false question. The scores of the questionnaire range from zero to ten, where ten indicates all questions were answered correctly.

Sample and setting

A convenient sample consisting of second, third, and fourth-year AHP university students were asked to voluntarily participate in the study. The FAMS offers four-year Bachelor of Science programs of nine AHP majors. Of these, we approached eight majors including medical laboratory sciences, physical therapy, occupational therapy and speech pathology, dental technology, allied dental science, radiologic technology, and optometry. [18] Trained individuals were primarily defined as students who had CPR certification and/or hands-on training with post-training summative assessment by professionals. However, to be less restrictive, individuals or learned via interpersonal demonstration were also considered trained individuals.[19]

The principal investigator (AO) and research assistants recruited student participants, explained its purposes and collected surveys upon completion. A sample size larger than 500

participants is considered excellent in cross-sectional studies.[20] In addition, there were at least 30 participants in each major. Furthermore, participants who were in their first year and those included in the pilot study were excluded. First-year students were excluded as they can change their admissions, after their first year, to programs other than AHP. All participants in this study signed IRB informed consent forms and received no compensation for their participation.

Statistical analysis

Continuous variables were reported as means and standard deviations. Participants were categorised as trained if they have received any CPR training, whereas untrained individuals were students who never had any CPR training. Comparisons between trained and untrained groups performed using student's t-test or analysis of variance (ANOVA), as appropriate. Categorical data were presented as counts and proportions and the difference between trained and untrained groups was compared using chi-square tests. Associations with student knowledge (maximum potential score of 10 points) were examined using univariate linear regression analyses ($p<0.2$). Furthermore, to identify the variables independently associated with CPR knowledge, a multivariate regression model with stepwise backward elimination was used. In all multivariate regression analyses, a p-value of 0.05 was specified for addition to the model, whereas we specified $p > 0.1$ for removal from the model. Linear regression assumptions including collinearity were checked and no violation was present (None of Variable inflation factor (IVF) was over 5).[21] All statistical analysis was undertaken using STATA (version 14.0 Stata Corporation, College Station, TX, USA)

Ethical approval

Jordan University of Science and Technology Institutional Review Board approved the study (project number: 24/112/2018)

RESULTS

Descriptive analyses

The FAMS at JUST included 1,525 students of the second, third and fourth year, with about 70% females (n=1,068). Data were collected in April 2018 with 917 (60.1% of the total population) students responding to the survey, however, 883 (response rate of 96.3%) students had completed the survey successfully and were included in the final analysis. Whereas 3.7% were excluded due to incomplete surveys and missing key information.

Table 1 includes descriptive statistics of students as well as a comparison between those who had prior CPR training versus those who never had any CPR training. The mean age of participants was 21 years (±1.6) with the majority being females (73.05%). There was no statistically significant difference in CPR knowledge score between males and females (p=0.3). However, a statistically significant difference was observed between trained and untrained groups (p<0.001). Therefore, comparisons herein are based on the training.

Only 190 (21.5%) students in this study had previous CPR training (20% of males versus 21.8% of females). Trained participants were older than untrained (21.45 years (±1.5) versus 20.85 years (±1.6), p<0.001). In addition, students in their fourth year had a higher proportion of trained individuals (p<0.001). A higher proportion of trained were in physical therapy or occupational therapy programs (<0.001).

On the other hand, higher untrained proportions in participants from dental technology (p=0.002), medical laboratories (p =0.001) or speech and audiology programs (p=0.001). Moreover, no significant statistical difference was observed between the percentage of males and females in the trained and untrained groups (p=0.68). Also, no difference was observed

between students who reporting having a family member with cardiac history compared to those who did not (p = 0.7).

Table 1 Participants demographics with a comparison between CPR trained vs untrained participants

Characteristic	Total N=883 (%)	Trained N= 190 (%)	Untrained N=693 (%)	P*
Age (Mean(SD), years)	21 (1.6)	21.45 (1.5)	20.85 (1.6)	<0.001
Sex				
Male	238 (26.95)	49 (25.8)	189 (27.8)	0.68
Female	645 (73.05)	141 (74.2)	504 (72.2)	
Year of study				
Second	315 (35.7)	35 (18.4)	280 (40.4)	<0.001
Third	338 (38.3)	74 (38.9)	264 (38.1)	0.8
Fourth	230 (26.0)	81 (42.6)	149 (21.5)	<0.001
Having a family member with cardiac diseases				
Yes	260 (29.45)	58 (30.5)	202 (29.1)	0.7
No	623 (70.55)	132 (69.5)	491(70.9)	
Major				
Dental technology	192 (21.74)	26 (13.9)	166 (24.0)	0.002
Radiology	168 (19)	41 (21.6)	127 (18.3)	0.3
Medical laboratory sciences	141 (16)	19 (10)	122 (17.6)	0.011
Speech and audiology	113 (12.8)	11 (5.79)	102 (15.79)	0.001
Physical therapy	108 (12.23)	44 (23.16)	64 (9.24)	<0.001
Optometry	75 (8.49)	12 (6.32)	63 (9.1)	0.3
Occupational therapy	55 (6.23)	26 (13.68)	29 (4.18)	<0.001
Allied dental sciences	31 (3.5)	11 (5.79)	20 (2.9)	0.054

*Student t-test or chi-squared tests; SD: Standard Deviation

The majority of trained students were trained at the university (57.9%), followed by schools (17.9%), private work or non-governmental organisations (16.8%) or self-learning/private centres (7.4%). Motivations for CPR training included personal interest (44.4%), compulsory requirements (40.6%), and helping other people and having family members with heart diseases (15%).

Figure 1 includes the top five barriers that participants indicated for their inability to take/retake the CPR training. Top causes were unknown training locations (33%) and the lack of time (32.1%).

The majority of participants (68.9%) indicated that they were willing to enrol in CPR training (or retraining). Helping people (43.7%) and personal interest (41.9%) were the top two motivators to learn or retrain in CPR (figure 2).

Table 2 summarises the knowledge scores and their differences among different groups. The overall mean score was 3.9 (±1.67) out of ten maximum potential points. The trained group had a higher mean score compared to the untrained group (4.6 (±1.67) vs. 3.75 (±1.6), p<0.001). Moreover, a higher knowledge score was found with an increased level of study (p=0.049). Also, significant differences in knowledge scores were found among academic pragmas (p<0.001). Additionally, while physical therapy and occupational therapy had the highest mean scores of 4.8 (±1.6) 4.5 (±1.6) respectively, speech and audiology students had the lowest mean score of 3.3 (±1.4).

Table 2 Summary and comparisons of knowledge scores

Knowledge questions	**N (%)**	**Mean (SD)**	***P****
Total knowledge score regarding CPR	**883 (100%)**	3.9 (1.67)	--
Training			
Trained	190 (21.5)	4.6 (1.6)	<0.001
Untrained	693 (79.5)	3.75 (1.6)	
Sex			0.29
Male	238 (26.95)	3.84 (1.7)	
Female	645 (73.05)	3.98 (1.6)	
Year of study			0.049
Second	315 (35.7)	3.78 (1.68)	
Third	338 (38.3)	3.96 (1.6)	
Fourth	230 (26.0)	4.13 (1.74)	
Having a family member with cardiac diseases			0.085
Yes	260 (29.45)	4.1 (1.6)	
No	623 (70.55)	3.88 (1.68)	
Major			<0.001
Dental technology	192 (21.74)	3.57 (1.6)	
Radiology	168 (19)	4.2 (1.87)	
Medical laboratory sciences	141 (16)	3.73 (1.5)	
Speech and audiology	113 (12.8)	3.3 (1.4)	

Physical therapy	108 (12.23)	4.8 (1.6)
Optometry	75 (8.49)	4 (1.4)
Occupational therapy	55 (6.23)	4.5 (1.7)
Allied dental sciences	31 (3.5)	4.1 (1.6)

CPR: cardiopulmonary resuscitation; * Student t-test or one-way analysis of variance (ANOVA); SD: Standard Deviation

Furthermore, the knowledge score ranged from one to nine among trained individuals, with 108 students (56.8%) scoring five or more points. Also, when asked about the last time of training 33% had their training recently (< one year), 24.3% past two years, 27.6% in the past three to four years and 15.1% more than five years ago.

Regression analysis

Table 3 summarises the factors included in the regression analyses. Factors significantly associated with higher knowledge scores were previous CPR training (β =0.87; 95%CI: 0.61, 1.1; p<0.001), age (β = 0.075; 95%CI: 0.006, 0.14; p=0.032) and higher study level (β =0.35; 95% CI: 0.07, 0.64; p=0.015). Having a family member with cardiac disease was not statistically significant (β = 0.21; 95% CI: -0.3 0.45; p=0.085). Using a stepwise multivariate regression analysis with backward elimination, previous training remained statistically significant (Adjusted β = 0.87; 95% CI: 0.6, 1.13; p<0.001). Moreover, being in the physical therapy program was positively associated with higher knowledge scores (Adjusted β = 0.46; 95% CI: 0.1, 0.8; p=0.009). On the other hand, lower knowledge scores were associated with speech and audiology (Adjusted β = -0.8; 95% CI: 0.-1.18, -0.49; p<0.001), dental technology (Adjusted β = -0.5; 95% CI: -0.8, -0.23; p=0.001), and medical laboratory sciences programs (Adjusted β = -0.4; 95% CI: -0.7, -0.09; p=0.012). Factors included in the model were previous training, age, level of study, student's GPA, specific study majors and having a family member with a history cardiac disease.

Table 3 Linear regression analyses of factors associated with CPR knowledge

Characteristic	Univariate regression			Multivariate regression		
	β	P	95% CI	β	P	95% CI
CPR Trained	0.87	<0.001	0.61,1.1	0.6	<0.001	0.22, 1.87
Family history of cardiac disease	0.21	0.085	-0.03,0.45	-	-	-
level						
2nd year	-0.25	0.033	-0.48 -0.02	-	-	-
4th Year	0.26	0.04	0.008,0.5	-	-	-
Age	0.075	0.032	0.006,0.14	-	-	-
GPA	0.14	0.2	-0.078,0.37	-	-	-
Major						
Dental technology	-0.467	0.001	-0.73, -0.2	-0.5	0.001	-0.8, -0.23
Radiology	0.3	0.026	0.038, 0.6	-	-	-
Medical Laboratory sciences	-.239	0.118	0.54, 0.06	-0.4	0.012	-0.7, -0.09
Speech and audiology	-0.75	0.000	-1.01, -0.42	-0.8	0.000	-1.18, -0.49
Physical therapy	0.93	0.000	0.60, 1.26	0.46	0.009	0.1, 0.8
Occupational therapy	0.588	0.011	0.13, 1.0	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average

Furthermore, table 4 outlines the univariate and multivariate analyses examining the factors associated with knowledge among trained individuals. Time since last training and being enrolled in the physical therapy program were the only factors associated with CPR knowledge in both analyses. Compared to recent training (< one year), longer times since last training was negatively associated with the knowledge scores. In addition, being enrolled in the physical therapy program was positively associated with higher knowledge among trained individuals.

Table 4: Linear Regression analyses of factors associated with knowledge scores among trained individuals

Characteristic	Univariate regression			Multivariate regression		
	β	P	95% CI	β	P	95% CI
Time since last training						
Recent (<1 year)	Ref	-	-	Ref	-	-
Two years ago	-0.76	0.011	-1.3, -0.18	-0.73	0.014	-1.3, -0.15
Three to four years ago	-1.05	<0.001	-1.6, -0.49	-0.8	0.008	-1.4, -0.2
>five years	-1.9	<0.001	-2.6, -1.2	-1.6	<0.001	-2.3, -0.89
level						
2nd year	-0.62	0.042	-1.2, -0.02	-	-	-

Age	0.12	0.1	-0.04, 0.28			
Major						
Radiography	.48	0.094	0.08, 1.0			
Medical laboratory sciences	-.63	0.11	-1.4, 0.14			
Speech and audiology	-1.2	0.014	-2.2, -0.25			
Physical therapy	0.84	0.002	0.3, 1.39	0.78	0.01	0.19, 1.36
Optometry	-0.66	0.17	-1.6, 0.3			
Allied Dental sciences	-.85	0.093	-1.8, 0.14			
GPA	0.35	0.13	-0.1,0.8	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average; Nationality: Jordanian

DISCUSSION

The study aimed to explore the level of CPR knowledge among AHP students and possible factors that contribute to their knowledge. We recruited a representative sample from eight different majors from the FAMS. Our study shows a poor level of CPR knowledge among AHP students. Surprisingly, this poor knowledge is also observed among the trained group. We also identified an independent association between CPR training, and higher level of CPR knowledge as well as an association between the level of CPR knowledge and specific academic program in FAMS. Moreover, among trained individuals, times since last training and being a physical therapy student were the only factors predict trained individual level of knowledge. It is not surprising that training increases the level of knowledge. To our knowledge, this is the first and largest study to explore the level of knowledge among AHP students in Jordan. This study can guide future research and provide recommendations and be a model to improve the level of CPR Knowledge in Jordan as well as the Middle East and North Africa (MENA) region.

Although the variation is not too high, trained individuals were older than their untrained counterparts. This is due to the characteristics of the included sample (vast majority with age range 19 – 22 years old); therefore, a small variation will cause a significant difference. This may also be due to the increased likelihood of older student to obtain opportunities for training and study major requirements that involved CPR training.

More trained proportions and higher mean knowledge scores were found in physical therapy and occupational therapy programs. Whereas, less trained proportions were found in speech and audiology, medical laboratory sciences, and dental technology. This can be explained by the fact that physical therapy and occupational therapy curricula include an introduction course that mandates CPR training and evaluation. Furthermore, in the physical therapy

program, the curriculum also includes a cardiac rehabilitation course where students have also mandatory CPR training and evaluation with training being delivered by paramedic program staff.

The majority of participants who did not receive CPR training reported unawareness of training locations and the lack of time as the top barriers. Nevertheless, the majority of participants were willing to be enrolled or repeat CPR training, motivated by their willingness to help people in need and having a personal interest in learning CPR skills.

Our results are similar to other studies reporting higher knowledge among trained individuals, despite the poor level of knowledge. [22-25] Aroor et al., reported an overall awareness and knowledge of BLS mean score of 4.16 (SD± 1.40) of a 10 maximum indicating a poor knowledge score among nursing, dental, and medical individuals including undergraduate, internship, and postgraduate groups. However, these knowledge scores based on a survey about BLS knowledge which is not similar to our survey. In addition, the authors found that age, gender, level of training, program of study and previous exposure to basic life support (BLS) were significantly associated with knowledge level ($P < 0.05$). [23] While our regression analysis accounted for most of these factors, only CPR training and being in the physical therapy program were with the only significant predictors of better knowledge. Barriers to learning CPR, in the Aroor et al study, was similar to the top reported barriers in our study being lack of time and unawareness of where these workshops are held. [23]

Furthermore, a study in Pakistan including 250 medical students also reported that medical student with BLS training had higher knowledge (Mean, SD) compared to those untrained (6.13 ± 2.1 vs 4.94 ± 2.06, $p < 0.001$). [22] Moreover, Ghanem et al examined the knowledge of CPR among 823 medical university students reporting 27% of participants who received BLS

training. The study also reported similar results where CPR knowledge was associated with previous CPR training ($p<0.001$), despite their overall poor level of knowledge. The majority of participants were males (88.3% of 824) which is different from our cohort. In addition, despite the low percentage of female participants, the study reported higher knowledge scores among females ($p < 0.001$). [24]

Other international studies have also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] This may reflect that higher knowledge of CPR is associated with previous training. Although our study was not a cohort study, our results are in concurrence with other studies reporting that BLS skills deteriorate with time post education and training. [12 13 17]

Furthermore, it is alarming that, despite about one-third of the participants reported having family members with a cardiac history, this urges designing compulsory and regular training programs/courses or graduation requirements. This is arguably especially important for medical and health care majors, which are supported in recommendations made in numerous reports. [3 22 23 25] Such programs can teach hands-only/compressions only CPR, which is highly recommended by the American Heart Association[4] and was reported to be associated with participants being more willing to perform CPR and higher survival rates.[2]

To overcome the barriers to taking a CPR course, short training workshops (<30 minutes) can also be designed. [26] This can be combined by introducing media, mobile devices, and self-learning videos to expand the number of potential participants who are willing to learn CPR. [5 27] Furthermore, Arabic versions of CPR can be developed and validated for the public in Arabic speaking countries, so students and healthcare professionals can help training larger numbers of the population at life-threating risks.

It might be difficult to train all people in Jordan including Jordanian University students, therefore, it is essential to target high-risk groups and/or staff and students who are highly likely to encounter cardiac arrest patients. This may include training the students who report family members with cardiac diseases, students in health-related programs as well as students in non-medical programs with the likelihood to encounter cases that can benefit from CPR. Moreover, universities can adopt initiatives to increase training rates as well as maintaining these training. This may include train the trainers initiatives, where academic staff and students in health-related programs are trained by professionals to qualify them as trainers. This can be followed and/or accompanied by campaigns to train students and the public. Including professional mandatory CPR training and evaluation in certain courses in different study years may also aid in improving CPR knowledge. In addition, short educational videos can be distributed through university applications and can be a mandatory requirement for students' registration. Furthermore, a work requirement that mandates training in BLS can further improve the level of knowledge among AHP graduates and professionals.

In developed countries, CPR training is delivered to school students; however, this is not available in Jordan. [28 29] Therefore, similar programs can be adopted to train the teachers and students at various cities and schools in Jordan, this will increase the awareness of CPR and improve survival rate.

Although it could be more clinically relevant to display how many students know correct CPR, the aim of this study was to explore how much the FAMS students know about CPR using a 10-points scale. However, future research with different designs can consider measuring the proportion of participants who are able to perform CPR correctly.

The poor level of knowledge found in our study may indicate an inadequate knowledge level among professionals who interact with patients on a daily bases. Further studies are also recommended to examine the professional knowledge and attitude towards CPR in Jordan as well as skill and knowledge retention.

Limitations

The inherent nature of the cross-sectional design of this study and recall bias of CPR training may have affected reporting the association with knowledge. There is no standardised published survey regarding CPR knowledge; however, we adopted our questionnaire based on the AHA 2015 recommendations as well as the relevant literature regarding CPR. Moreover, an expert panel designed and reviewed the survey from paramedicine and other allied health science fields. The survey was also piloted to 20 AHP students and modified based on their feedback in an attempt to improve validity and reliability.

There is a paucity of research regarding CPR knowledge among AHP students in general. However, we compared our results to studies including university students with health-related majors including medicine, nursing and any allied health professions, which considered to be comparable to our cohort due to similar study designs and level of questions.

Generalisability

Although a potential gender skew may be questioned, this percentage is representative of the student in FAMS (70% females). This is more likely due to cultural uniqueness in Jordan, as more females are willing to enrol in health-related disciplines compared to males. Therefore, the gender distribution in this study is expected to be observed at other universities with faculties similar to FAMS at JUST as well as the MENA region. However, generalising the findings of our results should consider the inclusion criteria, type of

questions, setting, type of participants and the type of outcome measures used in this study. A poor level of knowledge could also be expected among the public in Jordan.

CONCLUSION

There is a poor level of knowledge CPR among AHP students in Jordan. However, higher knowledge scores were associated with previous CPR training as well as more recent training. The study also found that the top barriers were unawareness of training locations and lack of time. Finally, compulsory training courses, shorter training periods, and use of various media devices are recommended to reach wider communities. Various initiatives to increase the awareness of CPR among university students and other population are highly recommended.

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Data sharing statement: The data sets generated and/or analysed during the current study are not publicly available due to them containing information that could compromise research participant privacy/consent but are available from the corresponding author on reasonable request.

Contribution statement: Dr. Alaa Oteir (AO), conceived the study idea, collected the data, conducted the statistical analyses and drafted the manuscript. AO, Dr. Khader Almahdawai (KA), Dr. Saddam Kanaan (SK), Dr. Mahmoud Alwidyan (MA) and Prof. Brett Williams (BB), have made a considerable contribution to the study design, interpretation, writing and reviewing the manuscript. The final manuscript has been approved by all authors.

Patient and Public Involvement: No patient involved

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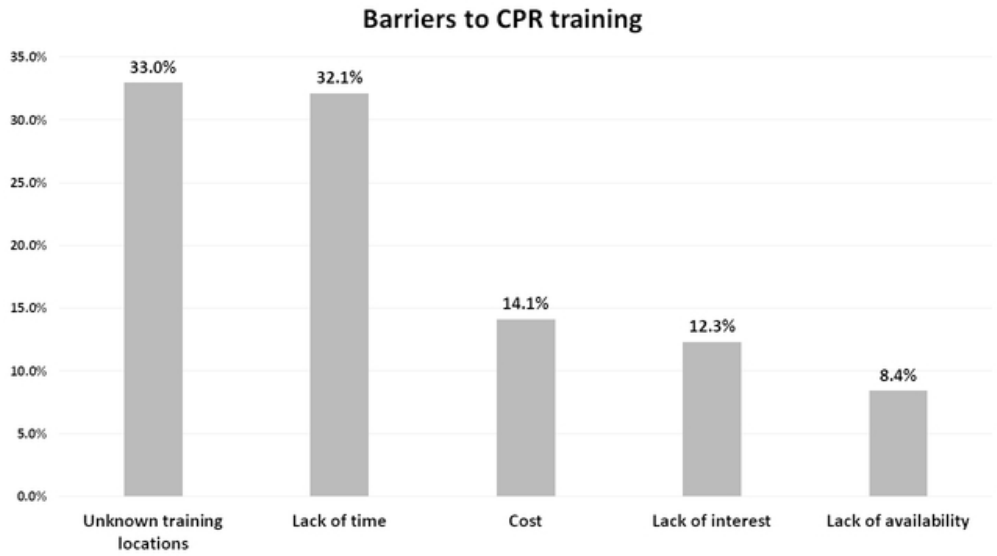
Figure legends

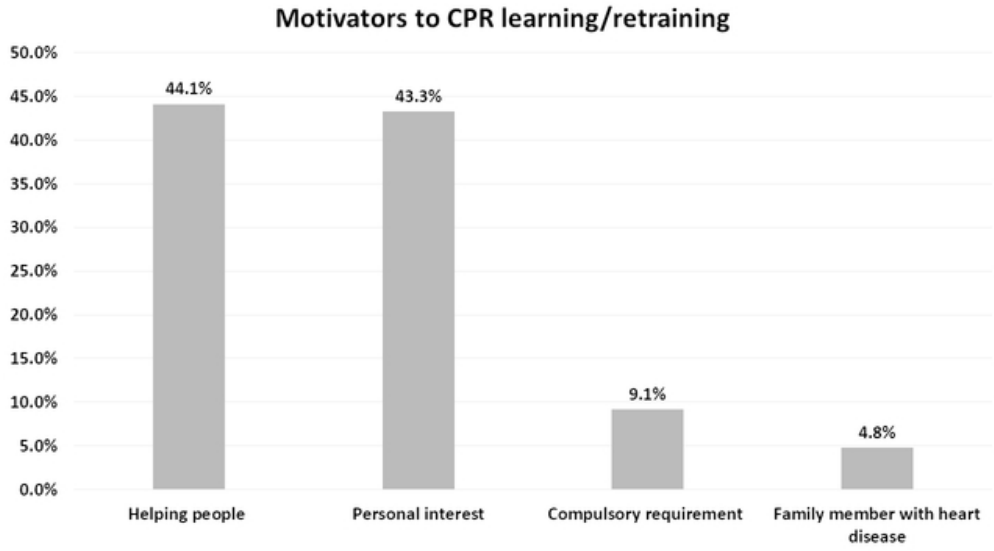
Figure 1. Barriers to CPR training (n=722)

Figure 2 Motivators for CPR training (n=689; not mutually exclusive)



Barriers to CPR training (n=722)

54x30mm (300 x 300 DPI)



Motivators for CPR training (n=689; not mutually exclusive)

54x30mm (300 x 300 DPI)

Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

Appendix A: survey questions

Knowledge questions	Answers
1.You were alone and sighted an adult laying on the floor, what would be the most important step to do?	• **Check consciousness and breathing (correct)** • Check pulse • Start compressions immediately • Call for help or emergency number
2.Which of the following is true regarding CPR?	• **CPR Starts with chest compressions** (correct) • CPR starts with mouth to mouth breathing • CPR starts with mouth to mouth and chest compressions simultaneously • Giving a mouth to mouth breathing is more important and superior to chest compression
3.What is the compressions to breathing ratio for an adult patient?	• **30 compression:2 breaths (correct)** • 30 compression:5 breaths • 5 compression:1 breath • 15 compression:1 breath
4.What is the number of compressions per minute for an adult patient?	• **100-120 compressions per minute (correct)** • More than 120 compressions per minute. • 80-100 compressions per minute • 60 – 80 compressions per minute
5.Which of the following is a characteristic of true effective CPR?	• **Allowing full chest recoil after each compression (correct)** • Compression without allowing chest recoil • Compressing fast but not hard • Compressing slowly
6.What is the depth of compression for an adult patient?	• **5 to 6 cm (correct)** • 2 to 3 cm • 3 to 4 cm • At least 6 cm
7.Once confirmed the need for CPR, chest compressions should start within	• **10 seconds (correct)** • 5 seconds • 15 seconds • 30 seconds
8.Which of the following is a characteristic of true effective CPR?	• **Pushing (compressing) hard and fast (correct)** • Pushing (compressing) with medium speed • Pushing (compressing) slowly • Pushing (compressing) with medium power
9.What is the emergency Number in Jordan?	• **911 (correct)** • 000 • 119 • 112
10.Sudden loss of consciousness/collapse may indicate a need for CPR.	• **Yes (correct)** • No

Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

2

Title: **Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	2, 5, 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5 - 7
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 9
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	NA

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8, 9
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	9-13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12, 13
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-18
Generalisability	21	Discuss the generalisability (external validity) of the study results	18-19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

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Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

Alaa O. Oteir, PhD[1,2]; **Khader Almhdawi**, PhD[3]; **Saddam F. Kanaan**, PhD[3]; **Mahmoud T. Alwidyan**, PhD[1]; **Brett Williams**, PhD[2]

1. Paramedicine Program, Department of Allied Medical Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan
2. Department of Community Emergency Health and Paramedic Practice, Monash University, Melbourne, Victoria, Australia
3. Department of Rehabilitation Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan

Email:

Alaa O. Oteir: aooteir@just.edu.jo **(corresponding author)**

Khader Almhdawi: khader@just.edu.jo

Saddam F. Kanaan: sfkanaan@just.edu.jo

Mahmoud Alwidyan: mtalwidyan@just.edu.jo

Brett Williams: Brett.williams@monash.edu

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Correspondence:

Alaa O. Oteir
Department of Allied Medical Sciences
Faculty of applied medical sciences
Jordan University of Science and Technolgy
B.O. Box 3030
Irbid, 22110
Jordan
ORCID: 0000-0002-3156-2773
E-mail: aooteir@just.edu.jo

ABSTRACT

Objective: To explore the level of cardiopulmonary resuscitation (CPR) knowledge among Allied Health Professions (AHP) students and its associated factors.

Methods: This is a cross-sectional study assessing CPR knowledge among AHP students. A multidisciplinary expert panel designed a survey, which then was piloted to 20 potential participants. The survey had two sections including demographics and knowledge questions. Knowledge questions scores ranged from zero to ten, where ten indicates all questions were answered correctly.

Results: A total of 883 students completed the surveys and were included in the study. The mean age was 21 years (±1.6) and the majority were females (73.1%). A total of 693 (78.5%) students did not receive previous CPR training and the top barriers to receiving CPR training were unawareness of training opportunities and a lack of time. Participants had a mean CPR knowledge score of 3.9 (±1.7) out of ten maximum potential points. Trained participants had a higher mean score compared to the untrained (4.6 (±1.7) vs. 3.8 (±1.6), p<0.001). Previous training (Adjusted β = 0.6; 95% CI: 0.4, 0.9; p<0.001) and being in the physical therapy program (Adjusted β = 0.5; 95% CI: 0.1, 0.8; p=0.01) were associated with higher knowledge.

Conclusion: There is poor knowledge of CPR among AHP students including trained individuals. Efforts to increase the awareness of CPR should target students and professionals who are highly likely to encounter patients requiring CPR. Compulsory training courses, shorter training periods as well as recurrent and regular refreshing courses and use of various media devices are recommended.

Keywords: cardiopulmonary resuscitation; CPR; knowledge; Allied health professions

Strengths and limitations

- This is the first study assessing CPR knowledge among allied health profession students in Jordan
- The results of this study will provide a baseline for future research regarding CPR among AHP in Jordan.
- Our study findings and recommendations can influence strategies to improve CPR knowledge and willingness to deliver CPR in Jordan
- There is no standardised or validated CPR survey. However, a multidisciplinary expert panel designed a survey, which was piloted to 20 potential participants.
- The inherent nature of the cross-sectional design of this study and potential recall bias of CPR training may have affected reporting the association with knowledge.

INTRODUCTION

Cardiac arrest is a major healthcare problem with poor survival rates. Early cardiopulmonary resuscitation (CPR), including bystander CPR, is significantly associated with improved survival to hospital discharge rates from out-of-hospital cardiac arrest (OHCA). [1-3] It is also a crucial element in the chain of survival in OHCA. [1 2 4] Therefore, training of large numbers of people continues to be a priority for the American Heart Association (AHA) and Red Cross/crescent organisations around the world. [5]

Reports indicated that the Middle-East and North Africa (MENA) populations are increasing significantly over upcoming decades, including Jordan. [6] With expected longevity, there will be an increasing incidence of cardiovascular diseases.[7] Moreover, a small study in Northern Jordan reported that only 3% OHCA patients survived (n=79), explaining this by the lack of CPR knowledge and skills. [8] Furthermore, allied health care professionals and students are expected, and often have to attend life-threating emergencies including cardiac arrests. Furthermore, international studies also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] Therefore, trained professionals or students may be able to perform early CPR, initiate resuscitation efforts and speed up the access to prehospital and definitive care. This may lead to increased survival rates and improving patient outcomes.[11-16] In addition, studies concluded that basic and advanced life support skills deteriorate after only six months post-training. [12 13 17] Therefore, it is imperative to continuously refresh trainees knowledge and skills on a regular basis.

There is a paucity of research regarding CPR knowledge in Jordan in general. Therefore, as a first step, this study explores the level of knowledge among Allied Health professions (AHP)

students and possible factors that contribute to their knowledge. This line of research is highly needed to establish effective strategies for improving CPR knowledge and skills in Jordan, including Jordanian universities. The study will also provide a baseline for future research regarding CPR knowledge and training among AHP professionals in Jordan. These effective strategies and future research may provide a model that can be adopted within Jordan as well as in the Middle East and North Africa (MENA) region.

Methods

Design and setting:

This is a cross-sectional study assessing CPR knowledge among AHP students in the Faculty of Applied Medical Science (FAMS). FAMS is a relatively newly established comprehensive allied health sciences faculty at Jordan University of Science and Technology (JUST) with nine undergraduate programs: medical laboratory sciences, physical therapy, occupational therapy, speech pathology, dental technology, allied dental science, radiologic technology, optometry, and paramedicine. A multidisciplinary expert panel including paramedicine, physical therapy, and occupational therapy academics designed and assessed the questionnaire for face and content validity. A second group of four paramedicine graduates also evaluated the survey providing feedback that further improved the validity of the survey. The study survey was primarily designed based on the 2015 American Heart Association recommendations for laypersons CPR training as well as the relevant literature (Survey questions and potential answers are provided in Appendix A).[1-4] The survey (in the Arabic language) was then piloted with a group of 20 AHP students and five paramedicine professionals to further evaluate its validity. Following this, the survey was updated based on students' and professionals' feedback. The main changes included changing one knowledge

question answers to give more clarity and modifying the wording of two other questions to improve readability. The expert panel approved the final version.

The survey was paper-based, anonymous and included two sections: the demographics section (section 1) included participants' demographic, university level (which year in the program), university cumulative grade point average (GPA), the status of previous CPR training, as well as motivators and barriers to learning CPR. The knowledge section (section 2) included ten questions that evaluated the knowledge about performing CPR and a question about the emergency phone number in Jordan. Nine of these questions had four different potential answers with only one correct answer, while one question was a true/false question. The scores of the questionnaire range from zero to ten, where ten indicates all questions were answered correctly.

Sample and setting

A convenient sample consisting of second, third, and fourth-year AHP university students were invited to voluntarily participate in the study. The FAMS offers four-year Bachelor of Science programs of nine AHP majors. Of these, we approached eight majors including medical laboratory sciences, physical therapy, occupational therapy and speech pathology, dental technology, allied dental science, radiologic technology, and optometry. [18] Trained individuals were primarily defined as students who had CPR certification and/or hands-on training with post-training summative assessment by professionals. However, to be less restrictive, individuals who learned via interpersonal demonstration were also considered trained individuals.[19]

The principal investigator (AO) and research assistants recruited student participants, explained its purposes and collected surveys upon completion. A sample size larger than 500 participants is considered excellent in cross-sectional studies.[20] In addition, there were at least 30 participants in each major. Furthermore, participants who were in their first year and those included in the pilot study were excluded. First-year students were excluded as they can change their admissions, after their first year, to programs other than AHP. All participants in this study signed IRB informed consent forms and received no compensation for their participation.

Statistical analysis

Continuous variables were reported as means and standard deviations. Participants were categorised as trained if they have received any CPR training, whereas untrained individuals were students who never had any CPR training. Comparisons between trained and untrained groups performed using independent student's t-test. To compre the mean between the groups, analysis of variance (ANOVA) with post-hoc analyses using Bonferroni correction was used. Categorical data were presented as counts and proportions, and the difference between trained and untrained groups was compared using chi-square tests followed by two-sample test of proportions to identify between-groups differences. Associations with students' knowledge (maximum potential score of 10 points) were examined using univariate linear regression analyses. Variables with a $p<0.2$ were then taken forward to the multivariate regression analysis. Furthermore, to identify the variables independently associated with CPR knowledge, a multivariate regression model with stepwise backward elimination was used. In all multivariate regression analyses, a p-value of 0.05 was specified for addition to the model, whereas we specified $p > 0.1$ for removal from the model. Linear regression assumptions including collinearity were checked and no violation was present (None of Variable inflation

factor (IVF) was over 5).[21] All statistical analysis was undertaken using STATA (version 14.0 Stata Corporation, College Station, TX, USA)

Ethical approval

Jordan University of Science and Technology Institutional Review Board approved the study (project number: 24/112/2018)

Patient and Public Involvement: No patients involved

RESULTS

Descriptive analyses

The FAMS at JUST included 1,525 students of the second, third and fourth year, with about 70% females (n=1,068). Data were collected in April 2018 with 917 (60.1% of the total population) students responding to the survey; however, 883 (response rate of 96.3%) students had completed the survey successfully and were included in the final analysis. Whereas 3.7% were excluded due to incomplete surveys and missing key information.

Table 1 includes descriptive statistics of students as well as comparisons between those who had prior CPR training versus those who never had any CPR training. The mean age of participants was 21 years (±1.6) with the majority being females (73.05%). Only 190 (21.5%) students in this study had previous CPR training (20.6% of males versus 21.9% of females). Trained participants were older than untrained (21.45 years (±1.5) versus 20.85 years (±1.6), p<0.001). Moreover, compared to second-year students, higher proportions of the trained individuals were fourth-year (42.6% vs 18.4%; p=0.01) and third-year (39% vs 18.4%; p=0.03).

Table 1 also shows statistically significant differences between at least two groups across majors. Based on the two samples test of proportions, a higher proportion of trained individuals was observed in the physical therapy compared to their untrained counterparts (23.2% vs 9.2%, p<0.04). On the other hand, a higher untrained proportion was observed in participants from dental technology compared to physical therapy (24% vs. 9.2; p=0.01), optometry (24% vs. 9.1%; p=0.01), occupational therapy (24% vs. 4.2; p=0.02) and allied dental sciences (24% vs. 2.9; p=0.03).

Moreover, compared to their trained counterparts, higher untrained proportions were observed in each of the medical laboratory sciences (86.5% vs. 13.5%; p<0.001), speech and audiology programs (90.3% vs. 9.7%; p<0.001), radiology (75.6% vs. 24.4%; p<0.001), optometry (84% vs 16%;<0.001) and dental technology (86.5. vs 13.5%;<0.001), with no significant differences in physical therapy, occupational therapy or allied dental science programs. Moreover, no significant statistical difference was observed between males and females in the trained and untrained groups (p=0.7) or grade point average (GPA; P=0.6). In addition, no difference was observed across majors in the trained group (all p>05.) or between students who reported having a family member with cardiac history compared to those who did not (p = 0.7).

Table 1 Participants demographics with a comparison between CPR trained vs. untrained participants

Characteristic	Total N=883 (%)	Trained N= 190 (%)	Untrained N=693 (%)	*P*
Age (Mean(SD), years)	21 (1.6)	21.5 (1.5)	20.9 (1.6)	<0.001¥
Sex				
Male	238 (27)	49 (25.8)	**189 (27.3)**	**0.7***
Female	645 (73.1)	141 (74.2)	**504 (72.7)**	
Year of study				**<0.001***
Second	315 (35.7)	35 (18.4)	280 (40.4)	
Third	338 (38.3)	74 (39)	264 (38.1)	
Fourth	230 (26.1)	81 (42.6)	149 (21.5)	
GPA	**3.1 (0.5)**	**3.1 (0.5)**	**3.1 (0.5)**	**0.6¥**
Having a family member with cardiac diseases				
Yes	260 (29.5)	58 (30.5)	202 (29.1)	0.7*
No	623 (70.6)	132 (69.5)	491(70.9)	
Major				**<0.001***
Dental technology	192 (21.7)	**26 (13.7)**	166 (24.0)	
Radiology	168 (19)	41 (21.6)	127 (18.3)	
Medical laboratory sciences	141 (16)	19 (10)	122 (17.6)	
Speech and audiology	113 (12.8)	11 (5.8)	**102 (14.7)**	
Physical therapy	108 (12.2)	44 (23.2)	64 (9.2)	
Optometry	75 (8.5)	12 (6.3)	63 (9.1)	
Occupational therapy	55 (6.2)	26 (13.7)	29 (4.2)	
Allied dental sciences	31 (3.5)	11 (5.79)	20 (2.9)	

¥Student t-test, *chi-squared tests; SD: Standard Deviation; GPA: grade point average

The majority of trained students were trained at the university (57.9%), followed by schools (17.9%), private work or non-governmental organisations (16.8%) or self-learning/private centres (7.4%).

Figure 1 includes the top five barriers that participants indicated for their inability to take the CPR training. The top causes were unknown training locations (33%) and the lack of time (32.1%). Also, motivations for CPR training, of those trained, included personal interest (44.4%), compulsory requirements (40.6%), helping other people, and having family members with heart diseases (15%). Moreover, the majority of participants (n=614, 69.5%) indicated that they were willing to enrol in CPR training (or retraining). Helping people (44.1%) and personal interest (41.9%) were the top two motivators to learn or retrain in CPR (figure 2).

Table 2 summarises the knowledge scores and their differences among different groups. The overall mean score was 3.9 (±1.67) out of ten maximum potential points. Additionally, while physical therapy and occupational therapy had the highest mean scores of 4.8 (±1.6) 4.5 (±1.6) respectively, speech and audiology students had the lowest mean score of 3.3 (±1.4).

There was no statistically significant difference in CPR knowledge score between males and females (p=0.3). However, the trained group had a higher mean score compared to the untrained group (4.6 (±1.6) vs. 3.8 (±1.6), p<0.001). Moreover, using ANOVA, the knowledge score was statistically different between at least two study levels (F (2, 880) =3, p=0.049). Post-hoc analysis, using Bonferroni correction, showed a statistically higher knowledge score among fourth-year students compared to second-year (4.1 vs 3.8, p=0.045).

In addition, ANOVA results showed significant differences in knowledge scores between at least two academic pragmas (F (7, 875) =9.99, p<0.001). Post-hoc analysis, using Bonferroni

correction, showed that mean knowledge scores of physical therapy, occupational therapy and radiology were significantly higher than those of speech and audiology (p<0.001) as well as dental technology (p<0.05). Furthermore, physical therapy had a higher knowledge score compared to optometry (p=0.05) and medical laboratory sciences (p<.001). No other differences were observed in the remaining comparisons.

Table 2 Summary and comparisons of knowledge scores

Knowledge questions	**N (%)**	**Mean (SD)**	***P****
Total knowledge score regarding CPR	**883 (100%)**	3.9 (1.7)	--
Training			
Trained	190 (21.5)	4.6 (1.6)	<0.001
Untrained	693 (79.5)	3.8 (1.6)	
Sex			0.3
Male	238 (**27**)	3.8 (1.7)	
Female	645 (**73.1**)	4 (1.6)	
Year of study			0.049
Second	315 (35.7)	3.8 (1.7)	
Third	338 (38.3)	4 (1.6)	
Fourth	230 (26.0)	4.1 (1.7)	
Having a family member with cardiac diseases			0.09
Yes	260 **(29.5)**	4.1 (1.6)	
No	623 **(70.6)**	3.9 (1.7)	
Major			<0.001
Dental technology	192 (21.7)	3.6 (1.6)	
Radiology	168 (19)	4.2 (1.**9**)	
Medical laboratory sciences	141 (16)	3.7 (1.5)	
Speech and audiology	113 (12.8)	3.3 (1.4)	
Physical therapy	108 (12.2)	4.8 (1.6)	
Optometry	75 (8.5)	4 (1.4)	
Occupational therapy	55 (6.2)	4.5 (1.7)	
Allied dental sciences	31 (3.5)	4.1 (1.6)	

CPR: cardiopulmonary resuscitation; * Student t-test or one-way analysis of variance (ANOVA); SD: Standard Deviation

Furthermore, the knowledge score ranged from one to nine among trained individuals, with 108 students (56.8%) scoring five or more points. In addition, when asked about the last time

of training 33% had their training recently (< one year), 24.3% past two years, 27.6% in the past three to four years and 15.1% more than five years ago.

Regression analysis

Table 3 summarises the factors included in the regression analyses. Factors significantly associated with higher knowledge scores were previous CPR training (β =0.9; 95%CI: 0.6, 1.1; p<0.001), age (β = 0.08; 95%CI: 0.01, 0.1; p=0.03), fourth-year study level (β =0.4; 95% CI: 0.1, 0.5; p=0.04) and being in the physical therapy, occupational therapy or radiology programs. Moreover, being in the second-year of study and enrolled in dental technology or speech and audiology programs were associated with lower knowledge scores. Having a family member with cardiac disease was not statistically significant (β = 0.2; 95% CI: -0.3 0.5; p=0.09).

Using a stepwise multivariate regression analysis with backward elimination, previous training remained statistically significant (Adjusted β = 0.6; 95% CI: 0.2, 0.9; p<0.001). Moreover, being in the physical therapy program was positively associated with higher knowledge scores (Adjusted β = 0.5; 95% CI: 0.1, 0.8; p=0.01). On the other hand, lower knowledge scores were associated with speech and audiology (Adjusted β = -0.8; 95% CI: 0.-1.2, -0.5; p<0.001), dental technology (Adjusted β = -0.5; 95% CI: -0.8, -0.3; p<0.001), and medical laboratory sciences programs (Adjusted β = -0.4; 95% CI: -0.7, -0.1; p=0.02).

Table 3 Linear regression analyses of factors associated with CPR knowledge

Characteristic	Univariate regression			Multivariate regression		
	β	P	95% CI	β	P	95% CI
CPR Trained (Ref: No)	0.9	<0.001	0.6, 1.1	0.6	<0.001	0.2, 0.9
Age	0.08	0.03	0.01, 0.1	-	-	-
level						
2nd year	-0.3	0.03	-0.48, -0.02	-	-	-
3rd year	0.03	0.8	-0.2, 0.3	-	-	-
4th Year	0.3	0.04	0.01, 0.5	-	-	-
Family history of cardiac disease (Ref: No)	0.2	0.09	-0.03, 0.5	-		
GPA	0.1	0.2	-0.1, 0.4	-	-	-
Major						
Dental technology	-0.5	0.001	-0.7, -0.2	-0.5	<0.001	-0.8, -0.3
Radiology	0.3	0.03	0.0, 0.6	-	-	-
Medical laboratory sciences	-0.2	0.1	0.5, 0.1	-0.4	0.02	-0.7, -0.1
Speech and audiology	-0.8	<0.001	-1.01, -0.4	-0.8	<0.001	-1.2, -0.5
Physical therapy	0.9	<0.001	0.6, 1.3	0.5	0.01	0.1, 0.8
Occupational therapy	0.6	0.01	0.1, 1.0	-	-	-
Allied dental sciences	0.2	0.5	-0.4, 0.8	-	-	-
Optometry	0.07	0.7	-0.3, 0.5	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average

Furthermore, table 4 outlines the univariate and multivariate analyses examining the factors associated with knowledge among trained individuals. Time since last training was the only factor associated with CPR knowledge in both analyses. Compared to recent training (< one year), longer times since last training was negatively associated with the knowledge scores.

Table 4: Linear Regression analyses of factors associated with knowledge scores among trained individuals

Characteristic	Univariate regression			Multivariate regression		
	β	P	95% CI	β	P	95% CI
Time since last training						
Recent (<1 year)	Ref	-	-	Ref	-	-
Two years ago	-0.8	0.01	-1.3, -0.2	-0.8	0.006	-1.4, -0.2
Three to four years ago	-1.1	<0.001	-1.6, -0.5	-1.1	<0.001	-1.6, -0.5
>five years	-1.9	<0.001	-2.6, -1.2	-1.9	<0.001	-2.6, -1.2
Level						
2nd year	-0.6	0.04	-1.2, -0.02	-	-	-
3rd year	0.2	0.5	-0.3, 0.6	-	-	-
4th year	0.2	0.3	-0.2, 0.7	-	-	-
Age	0.1	0.1	-0.04, 0.3	-	-	-
GPA	0.3	0.1	-0.1,0.8	-	-	-

Family history of cardiac disease (Ref: No)	0.1	0.6	-0.4, 0.6	-	-	-
Major						
Radiology	0.5	0.09	0.1, 1.0	-	-	-
Medical laboratory sciences	-0.6	0.1	-1.4, 0.14	-	-	-
Speech and audiology	-1.2	0.01	-2.2, -0.3	-	-	-
Physical therapy	0.8	0.002	0.3, 1.4	-	-	-
Optometry	-0.7	0.2	-1.6, 0.3	-	-	-
Allied Dental sciences	-0.9	0.09	-1.8, 0.1	-	-	-
Occupation therapy	0.2	0.5	-0.5, 9	-	-	-
Dental technology	-0.4	0.2	-1.1, 0.3	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average; Nationality: Jordanian

DISCUSSION

The study aimed to explore the level of CPR knowledge among AHP students and possible factors that contribute to their knowledge. We recruited a representative sample from eight different majors from the FAMS. Our study shows a poor level of CPR knowledge among AHP students. Surprisingly, this poor knowledge is also observed among the trained group. We also identified an independent association between CPR training and being in the physical therapy**.** On the other hand, lower knowledge scores were associated with speech and audiology, dental technology, and medical laboratory sciences programs. Moreover, among trained individuals, time since last training was the only factor to predict trained individual level of knowledge. To our knowledge, this is the first study to explore the level of knowledge among AHP students in Jordan. This study can guide future research and provide recommendations and be a model to improve the level of CPR Knowledge in Jordan as well as the Middle East and North Africa (MENA) region.

Although the variation is not too high, trained individuals were older than their untrained counterparts. This is due to the characteristics of the included sample (the vast majority with age range 19 – 22 years old); therefore, a small variation will cause a significant difference. This may also be due to the increased likelihood of older student to obtain opportunities for training and study major requirements that involved CPR training.

Higher mean knowledge scores were found in physical therapy, occupational therapy and radiology than those of dental technology and speech and audiology. This can be explained by the fact that physical therapy and occupational therapy curricula include an introduction course that mandates CPR training and evaluation. Furthermore, in the physical therapy program, the curriculum also includes a cardiac rehabilitation course where students have

also mandatory CPR training and evaluation with training being delivered by paramedic program staff. Finally, the radiology program also have a patient-care oriented course which also mandates CPR training.

The majority of participants who did not receive CPR training reported unawareness of training locations and the lack of time as the top barriers. Nevertheless, the majority of participants were willing to be enrolled or repeat CPR training, motivated by their willingness to help people in need and having a personal interest in learning CPR skills.

Despite the differences in populations and survey questions, our results are similar to other studies reporting higher knowledge among trained individuals, despite the poor level of knowledge. [22-25] Aroor et al., in study conducted in South India, reported an overall awareness and knowledge of BLS mean score of 4.16 (SD± 1.40) of a 10 maximum indicating a poor knowledge score among nursing, dental, and medical individuals including undergraduate, internship, and postgraduate groups. However, these knowledge scores based on a survey about BLS knowledge which is not similar to our survey. In addition, the authors found that age, gender, level of training, program of study and previous exposure to basic life support (BLS) were significantly associated with knowledge level. [23] While our regression analysis accounted for most of these factors, only CPR training and being in the physical therapy program were with the only significant predictors of better knowledge. Barriers to learning CPR, in the Aroor et al study, was similar to the top reported barriers in our study being lack of time and unawareness of where these workshops are held. [23]

Furthermore, a study in Pakistan including 250 medical students also reported that medical students with BLS training had higher knowledge (Mean, SD) compared to those untrained. [22] Moreover, Ghanem et al examined the knowledge of CPR among 823 medical university

students reporting 27% of participants who received BLS training. The study also reported similar results where CPR knowledge was associated with previous CPR training, despite their overall poor level of knowledge. The majority of participants were males (88.3% of 824) which is different from our study. In addition, despite the low percentage of female participants, the study reported higher knowledge scores among females ($p < 0.001$). [24]

Other international studies have also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] This may reflect that higher knowledge of CPR is associated with previous training. Our results are in concurrence with other studies reporting that BLS skills deteriorate with time post education and training. [12 13 17] Therefore, continuous education can increase the level of knowledge and optimise CPR performance.

Furthermore, the poor level of knowledge urges designing compulsory and regular training programs/courses or graduation requirements. This is arguably especially important for medical and health care majors, which are supported in recommendations made in numerous reports. [3 22 23 25] Such programs can teach hands-only/compressions only CPR, which is highly recommended by the American Heart Association[4] and was reported to be associated with participants being more willing to perform CPR and higher survival rates.[2]

To overcome the barriers to taking a CPR course, short training workshops (<30 minutes) can also be designed. [26] This can be combined by introducing media, mobile devices, and self-learning videos to expand the number of potential participants who are willing to learn CPR. [5 27] Furthermore, Arabic versions of CPR can be developed and validated for the public in Arabic speaking countries, so students and healthcare professionals can help training larger numbers of the population at life-threating risks.

It might be difficult to train all people in Jordan including Jordanian University students, therefore, it is essential to target high-risk groups and/or staff and students who are highly likely to encounter cardiac arrest patients. This may include training the students who report family members with cardiac diseases, students in health-related programs as well as students in non-medical programs with the likelihood to encounter cases that can benefit from CPR. Moreover, universities can adopt initiatives to increase training rates as well as maintaining these training. This may include train the trainers initiatives, where academic staff and students in health-related programs are trained by professionals to qualify them as trainers. This can be followed and/or accompanied by campaigns to train students and the public. Including professional mandatory CPR training and evaluation in certain courses in different study years may also aid in improving CPR knowledge. In addition, short educational videos can be distributed through university applications and can be a mandatory requirement for students' registration. Furthermore, a work requirement that mandates training in BLS can further improve the level of knowledge among AHP graduates and professionals.

In developed countries, CPR training is delivered to school students; however, this is not available in Jordan. [28 29] Therefore, similar programs can be adopted to train the teachers and students at various cities and schools in Jordan, this will increase the awareness of CPR and improve survival rate. Moreover, global initiatives such as Restart-a-Heart Day held in October 2018, in which JUST participated and trained over 800 students and staff. This initiative was supported by international Liaison Committee on Resuscitation (ILCOR) and trained over 200,000 potential lifesavers.

Although it could be more clinically relevant to display how many students know correct CPR, the aim of this study was to explore how much the FAMS students know about CPR using a 10-points scale. However, future research with different designs can consider measuring the proportion of participants who are able to perform CPR correctly.

The poor level of knowledge found in our study may indicate an inadequate knowledge level among professionals who interact with patients on a daily bases. Further studies are also recommended to examine the professional knowledge and attitude towards CPR in Jordan as well as skill and knowledge retention.

Limitations

The inherent nature of the cross-sectional design of this study and recall bias of CPR training may have affected reporting the association with knowledge. There is no standardised published survey regarding CPR knowledge; however, we adopted our questionnaire based on the AHA 2015 recommendations as well as the relevant literature regarding CPR. [1-4] Moreover, an expert panel designed and reviewed the survey from paramedicine and other allied health science fields. The survey was also piloted to 20 AHP students and modified based on their feedback in an attempt to improve validity and reliability.

There is a paucity of research regarding CPR knowledge among AHP students in general. However, we compared our results to studies including university students with health-related majors including medicine, nursing and any allied health professions, which considered to be comparable to our cohort due to similar study designs and level of questions.

Generalisability

Although a potential gender skew may be questioned, this percentage is representative of the student in FAMS (70% females). This is more likely due to cultural uniqueness in Jordan, as more females are willing to enrol in health-related disciplines compared to males. Therefore, the gender distribution in this study is expected to be observed at other universities with faculties similar to FAMS at JUST as well as the MENA region. However, generalising the findings of our results should consider the inclusion criteria, type of questions, setting, type of participants and the type of outcome measures used in this study. As per the reported barriers of the AHP students, which are considered a highly educated group in the Jordanian population, a poor level of knowledge could also be expected among the public in Jordan. This poor knowledge is also expected due to lack of public initiatives and mandatory training courses in Jordan.

CONCLUSION

There is a poor level of knowledge CPR among AHP students in Jordan. However, higher knowledge scores were associated with previous CPR training as well as more recent training. The study also found that the top barriers were unawareness of training locations and lack of time. Finally, compulsory training courses, shorter training periods, and use of various media devices are recommended to reach wider communities. Various initiatives to increase the awareness of CPR among university students and other population are highly recommended.

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Data sharing statement: The data sets generated and/or analysed during the current study are not publicly available due to them containing information that could compromise research participant privacy/consent but are available from the corresponding author on reasonable request.

Contribution statement: Dr. Alaa Oteir (AO), conceived the study idea, collected the data, conducted the statistical analyses and drafted the manuscript. AO, Dr. Khader Almahdawai (KA), Dr. Saddam Kanaan (SK), Dr. Mahmoud Alwidyan (MA) and Prof. Brett Williams (BB), have made a considerable contribution to the study design, interpretation, writing and reviewing the manuscript. The final manuscript has been approved by all authors.

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Figure legends

Figure 1. Barriers to CPR training (n=722)

Figure 2 Motivators for CPR training/retraining (n=614; not mutually exclusive)

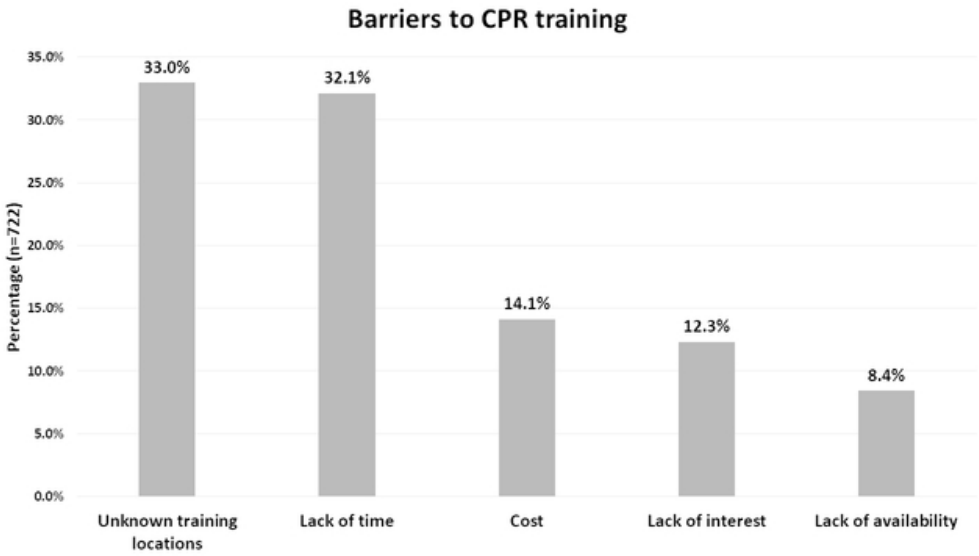

Figure 1. Barriers to CPR training (n=722)

27x15mm (600 x 600 DPI)

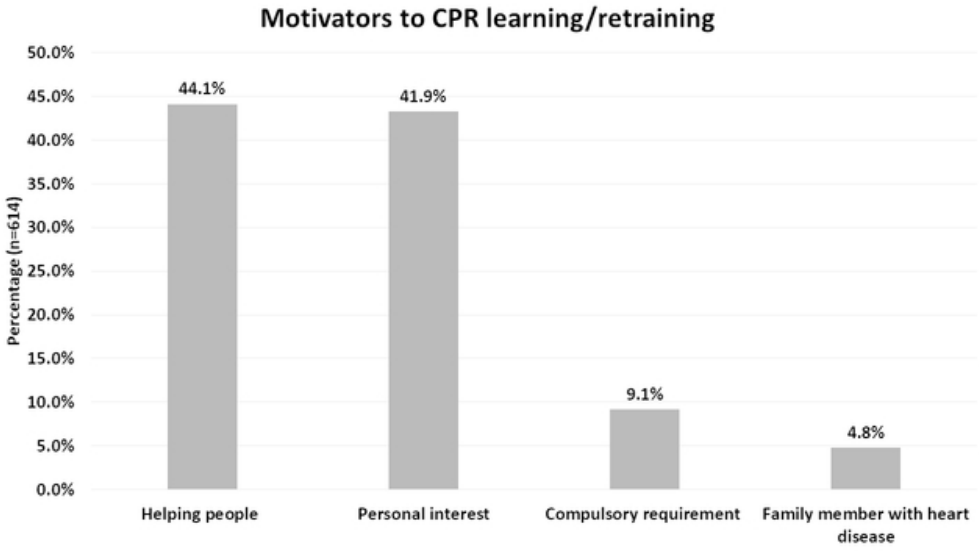

Figure 2 Motivators for CPR training/retraining (n=614; not mutually exclusive)

27x15mm (600 x 600 DPI)

Appendix A: survey questions

Knowledge questions	Answers
1.You were alone and sighted an adult laying on the floor, what would be the most important step to do?	• **Check consciousness and breathing (correct)** • Check pulse • Start compressions immediately • Call for help or emergency number
2.Which of the following is true regarding CPR?	• **CPR Starts with chest compressions** (correct) • CPR starts with mouth to mouth breathing • CPR starts with mouth to mouth and chest compressions simultaneously • Giving a mouth to mouth breathing is more important and superior to chest compression
3.What is the compressions to breathing ratio for an adult patient?	• **30 compression:2 breaths (correct)** • 30 compression:5 breaths • 5 compression:1 breath • 15 compression:1 breath
4.What is the number of compressions per minute for an adult patient?	• **100-120 compressions per minute (correct)** • More than 120 compressions per minute. • 80-100 compressions per minute • 60 – 80 compressions per minute
5.Which of the following is a characteristic of true effective CPR?	• **Allowing full chest recoil after each compression (correct)** • Compression without allowing chest recoil • Compressing fast but not hard • Compressing slowly
6.What is the depth of compression for an adult patient?	• **5 to 6 cm (correct)** • 2 to 3 cm • 3 to 4 cm • At least 6 cm
7.Once confirmed the need for CPR, chest compressions should start within a maximum of	• **10 seconds (correct)** • 5 seconds • 15 seconds • 30 seconds
8.Which of the following is a characteristic of true effective CPR?	• **Pushing (compressing) hard and fast (correct)** • Pushing (compressing) with medium speed • Pushing (compressing) slowly • Pushing (compressing) with medium power
9.What is the emergency Number in Jordan?	• **911 (correct)** • 000 • 119 • 112

10.Sudden loss of consciousness/collapse may indicate a need for CPR.	• **Yes (correct)** • No

Title: **Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	2, 5, 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5 - 7
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9,10
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	9-15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13-16
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

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Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study

Alaa O. Oteir, PhD[1,2]; **Khader Almhdawi**, PhD[3]; **Saddam F. Kanaan**, PhD[3]; **Mahmoud T. Alwidyan**, PhD[1]; **Brett Williams**, PhD[2]

1. Paramedicine Program, Department of Allied Medical Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan
2. Department of Community Emergency Health and Paramedic Practice, Monash University, Melbourne, Victoria, Australia
3. Department of Rehabilitation Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan

Email:

Alaa O. Oteir: aooteir@just.edu.jo **(corresponding author)**

Khader Almhdawi: khader@just.edu.jo

Saddam F. Kanaan: sfkanaan@just.edu.jo

Mahmoud Alwidyan: mtalwidyan@just.edu.jo

Brett Williams: Brett.williams@monash.edu

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Correspondence:

Alaa O. Oteir
Department of Allied Medical Sciences
Faculty of applied medical sciences
Jordan University of Science and Technolgy
B.O. Box 3030
Irbid, 22110
Jordan
ORCID: 0000-0002-3156-2773
E-mail: aooteir@just.edu.jo

ABSTRACT

Objective: To explore the level of cardiopulmonary resuscitation (CPR) knowledge among Allied Health Professions (AHP) students and its associated factors.

Methods: This is a cross-sectional study assessing CPR knowledge among AHP students. A multidisciplinary expert panel designed a survey, which then was piloted to 20 potential participants. The survey had two sections including demographics and knowledge questions. Knowledge questions scores ranged from zero to ten, where ten indicates all questions were answered correctly.

Results: A total of 883 students completed the surveys and were included in the study. The mean age was 21 years (±1.6) and the majority were females (73.1%). A total of 693 (78.5%) students did not receive previous CPR training and the top barriers to receiving CPR training were unawareness of training opportunities and a lack of time. Participants had a mean CPR knowledge score of 3.9 (±1.7) out of ten maximum potential points. Trained participants had a higher mean score compared to the untrained (4.6 (±1.7) vs. 3.8 (±1.6), p<0.001). Previous training (Adjusted β = 0.6; 95% CI: 0.4, 0.9; p<0.001) and being in the physical therapy program (Adjusted β = 0.5; 95% CI: 0.1, 0.8; p=0.01) were associated with higher knowledge.

Conclusion: There is poor knowledge of CPR among AHP students including trained individuals. Efforts to increase the awareness of CPR should target students and professionals who are highly likely to encounter patients requiring CPR. Compulsory training courses, shorter training periods as well as recurrent and regular refreshing courses and use of various media devices are recommended.

Keywords: cardiopulmonary resuscitation; CPR; knowledge; Allied health professions

Strengths and limitations

- This is the first study assessing CPR knowledge among allied health profession students in Jordan
- The results of this study will provide a baseline for future research regarding CPR among AHP in Jordan.
- Our study findings and recommendations can influence strategies to improve CPR knowledge and willingness to deliver CPR in Jordan
- There is no standardised or validated CPR survey. However, a multidisciplinary expert panel designed a survey, which was piloted to 20 potential participants.
- The inherent nature of the cross-sectional design of this study and potential recall bias of CPR training may have affected reporting the association with knowledge.

INTRODUCTION

Cardiac arrest is a major healthcare problem with poor survival rates. Early cardiopulmonary resuscitation (CPR), including bystander CPR, is significantly associated with improved survival to hospital discharge rates from out-of-hospital cardiac arrest (OHCA). [1-3] It is also a crucial element in the chain of survival in OHCA. [1 2 4] Therefore, training of large numbers of people continues to be a priority for the American Heart Association (AHA) and Red Cross/crescent organisations around the world. [5]

Reports indicated that the Middle-East and North Africa (MENA) populations are increasing significantly over upcoming decades, including Jordan. [6] With expected longevity, there will be an increasing incidence of cardiovascular diseases.[7] Moreover, a small study in Northern Jordan reported that only 3% OHCA patients survived (n=79), explaining this by the lack of CPR knowledge and skills. [8] Furthermore, allied health care professionals and students are expected, and often have to attend life-threating emergencies including cardiac arrests. Furthermore, international studies also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] Therefore, trained professionals or students may be able to perform early CPR, initiate resuscitation efforts and speed up the access to prehospital and definitive care. This may lead to increased survival rates and improving patient outcomes.[11-16] In addition, studies concluded that basic and advanced life support skills deteriorate after only six months post-training. [12 13 17] Therefore, it is imperative to continuously refresh trainees knowledge and skills on a regular basis.

There is a paucity of research regarding CPR knowledge in Jordan in general. Therefore, as a first step, this study explores the level of knowledge among Allied Health professions (AHP)

students and possible factors that contribute to their knowledge. This line of research is highly needed to establish effective strategies for improving CPR knowledge and skills in Jordan, including Jordanian universities. The study will also provide a baseline for future research regarding CPR knowledge and training among AHP professionals in Jordan. These effective strategies and future research may provide a model that can be adopted within Jordan as well as in the Middle East and North Africa (MENA) region.

Methods

Design and setting:

This is a cross-sectional study assessing CPR knowledge among AHP students in the Faculty of Applied Medical Science (FAMS). FAMS is a relatively newly established comprehensive allied health sciences faculty at Jordan University of Science and Technology (JUST) with nine undergraduate programs: medical laboratory sciences, physical therapy, occupational therapy, speech pathology, dental technology, allied dental science, radiologic technology, optometry, and paramedicine. A multidisciplinary expert panel including paramedicine, physical therapy, and occupational therapy academics designed and assessed the questionnaire for face and content validity. A second group of four paramedicine graduates also evaluated the survey providing feedback that further improved the validity of the survey. The study survey was primarily designed based on the 2015 American Heart Association recommendations for laypersons CPR training as well as the relevant literature (Survey questions and potential answers are provided in Appendix A).[1-4] The survey (in the Arabic language) was then piloted with a group of 20 AHP students and five paramedicine professionals to further evaluate its validity. Following this, the survey was updated based on students' and professionals' feedback. The main changes included changing one knowledge

question answers to give more clarity and modifying the wording of two other questions to improve readability. The expert panel approved the final version.

The survey was paper-based, anonymous and included two sections: the demographics section (section 1) included participants' demographic, university level (which year in the program), university cumulative grade point average (GPA), the status of previous CPR training, as well as motivators and barriers to learning CPR. The knowledge section (section 2) included ten questions that evaluated the knowledge about performing CPR and a question about the emergency phone number in Jordan. Nine of these questions had four different potential answers with only one correct answer, while one question was a true/false question. The scores of the questionnaire range from zero to ten, where ten indicates all questions were answered correctly.

Sample and setting

A convenient sample consisting of second, third, and fourth-year AHP university students were invited to voluntarily participate in the study. The FAMS offers four-year Bachelor of Science programs of nine AHP majors. Of these, we approached eight majors including medical laboratory sciences, physical therapy, occupational therapy and speech pathology, dental technology, allied dental science, radiologic technology, and optometry. [18] Trained individuals were primarily defined as students who had CPR certification and/or hands-on training with post-training summative assessment by professionals. However, to be less restrictive, individuals who learned via interpersonal demonstration were also considered trained individuals.[19]

The principal investigator (AO) and research assistants recruited student participants, explained its purposes and collected surveys upon completion. A sample size larger than 500 participants is considered excellent in cross-sectional studies.[20] In addition, there were at least 30 participants in each major. Furthermore, participants who were in their first year and those included in the pilot study were excluded. First-year students were excluded as they can change their admissions, after their first year, to programs other than AHP. All participants in this study signed IRB informed consent forms and received no compensation for their participation.

Statistical analysis

Continuous variables were reported as means and standard deviations. Participants were categorised as trained if they have received any CPR training, whereas untrained individuals were students who never had any CPR training. Comparisons between trained and untrained groups performed using independent student's t-test. To compare the mean between the groups, analysis of variance (ANOVA) with post-hoc analyses using Bonferroni correction was used. Categorical data were presented as counts and proportions, and the difference between trained and untrained groups was compared using chi-square tests followed by two-sample test of proportions to identify between-groups differences. Associations with students' knowledge (maximum potential score of 10 points) were examined using univariate linear regression analyses. Variables with a $p<0.2$ were then taken forward to the multivariate regression analysis. Furthermore, to identify the variables independently associated with CPR knowledge, a multivariate regression model with stepwise backward elimination was used. In all multivariate regression analyses, a p-value of 0.05 was specified for addition to the model, whereas we specified $p > 0.1$ for removal from the model. Linear regression assumptions including collinearity were checked and no violation was present (None of Variable inflation

factor (IVF) was over 5).[21] All statistical analysis was undertaken using STATA (version 14.0 Stata Corporation, College Station, TX, USA)

Ethical approval

Jordan University of Science and Technology Institutional Review Board approved the study (project number: 24/112/2018)

Patient and Public Involvement: No patients involved

RESULTS

Descriptive analyses

The FAMS at JUST included 1,525 students of the second, third and fourth year, with about 70% females (n=1,068). Data were collected in April 2018 with 917 (60.1% of the total population) students responding to the survey; however, 883 (response rate of 96.3%) students had completed the survey successfully and were included in the final analysis. Whereas 3.7% were excluded due to incomplete surveys and missing key information.

Table 1 includes descriptive statistics of students as well as comparisons between those who had prior CPR training versus those who never had any CPR training. The mean age of participants was 21 years (±1.6) with the majority being females (73.1%). Only 190 (21.5%) students in this study had previous CPR training (20.6% of males versus 21.9% of females). Trained participants were older than untrained (21.5 years (±1.5) versus 20.9 years (±1.6), p<0.001). Moreover, compared to second-year students, higher proportions of trained individuals were from fourth-year (42.6% vs 18.4%; p=0.01) and third-year (39% vs 18.4%; p=0.03). Additionally, no significant statistical differences were observed based on sex (p=0.7), having family members with a cardiac history (p = 0.7), or grade point average (GPA; P=0.6).

Table 1 also shows statistically significant differences between at least two groups across the AHP majors and/or between trained and untrained individuals. Based on the two samples test of proportions, the only statistical difference between trained and untrained groups was observed in the physical therapy major (23.2% vs 9.2%, p=0.046). On the other hand, when comparing untrained proportions across majors, a higher untrained proportion was observed in participants from dental technology compared to physical therapy (24.0% vs. 9.2%; p=0.01),

optometry (24.0% vs. 9.1%; p=0.01), occupational therapy (24.0% vs. 4.2%; p=0.02) and allied dental sciences (24% vs. 2.9%; p=0.03) whereas no differences were observed across majors in the trained group (all p>0.05).

Table 1 Participants demographics with a comparison between CPR trained vs. untrained participants

Characteristic	Total N=883 (%)	Trained N= 190 (%)	Untrained N=693 (%)	*P*
Age (Mean(SD), years)	21 (1.6)	21.5 (1.5)	20.9 (1.6)	<0.001¥
Sex				
Male	238 (**27.0**)	49 (25.8)	189 (27.3)	0.7*
Female	645 (73.1)	141 (74.2)	504 (72.7)	
Year of study				<0.001*
Second	315 (35.7)	35 (18.4)	280 (40.4)	
Third	338 (38.3)	74 (**39.0**)	264 (38.1)	
Fourth	230 (26.1)	81 (42.6)	149 (21.5)	
GPA	3.1 (0.5)	3.1 (0.5)	3.1 (0.5)	0.6¥
Having a family member with cardiac diseases				
Yes	260 (29.5)	58 (30.5)	202 (29.1)	0.7*
No	623 (70.6)	132 (69.5)	491(70.9)	
Major				<0.001*
Dental technology	192 (21.7)	26 (13.7)	166 (24.0)	
Radiology	168 (19.0)	41 (21.6)	127 (18.3)	
Medical laboratory sciences	141 (16.0)	19 (10.0)	122 (17.6)	
Speech and audiology	113 (12.8)	11 (5.8)	102 (14.7)	
Physical therapy	108 (12.2)	44 (23.2)	64 (9.2)	
Optometry	75 (8.5)	12 (6.3)	63 (9.1)	
Occupational therapy	55 (6.2)	26 (13.7)	29 (4.2)	
Allied dental sciences	31 (3.5)	11 (5.8)	20 (2.9)	

¥Student t-test, *chi-squared tests; SD: Standard Deviation; GPA: grade point average

The majority of trained students were trained at the university (57.9%), followed by schools (17.9%), private work or non-governmental organisations (16.8%) or self-learning/private centres (7.4%).

Figure 1 includes the top five barriers that participants indicated for their inability to take the CPR training. The top causes were unknown training locations (33.0%) and the lack of time (32.1%). Moreover, as shown in figure 2, the majority of participants (n=614, 69.5%) indicated

that they were willing to enrol in CPR training (or retraining). Helping people (44.1%) and personal interest (41.9%) were the top two motivators to learn or retrain in CPR. Also, motivations for CPR training, of those trained, included personal interest (44.4%), compulsory requirements (40.6%), helping other people, and having family members with heart diseases (15.0%).

Table 2 summarises the knowledge scores and their differences among different groups. The overall mean score was 3.9 (±1.7) out of ten maximum potential points. Additionally, while physical therapy and occupational therapy had the highest mean scores of 4.8 (±1.6) 4.5 (±1.6) respectively, speech and audiology students had the lowest mean score of 3.3 (±1.4).

There was no statistically significant difference in CPR knowledge score between males and females (p=0.3). However, the trained group had a higher mean score compared to the untrained group (4.6 (±1.6) vs. 3.8 (±1.6), p<0.001). Moreover, using ANOVA, the knowledge score was statistically different between at least two study levels (F (2, 880) =3, p=0.049). Post-hoc analysis, using Bonferroni correction, showed a statistically higher knowledge score among fourth-year students compared to second-year (4.1 vs 3.8, p=0.045).

In addition, ANOVA results showed significant differences in knowledge scores between at least two academic pragmas (F (7, 875) =9.99, p<0.001). Post-hoc analysis, using Bonferroni correction, showed that mean knowledge scores of physical therapy, occupational therapy and radiology were significantly higher than those of speech and audiology (p<0.001) as well as dental technology (p<0.05). Furthermore, physical therapy had a higher knowledge score compared to optometry (p=0.05) and medical laboratory sciences (p<0.001). No other differences were observed in the remaining comparisons.

Table 2 Summary and comparisons of knowledge scores

Knowledge questions	N (%)	Mean (SD)	*P**
Total knowledge score regarding CPR	**883 (100%)**	3.9 (1.7)	--
Training			
Trained	190 (21.5)	4.6 (1.6)	<0.001
Untrained	693 (79.5)	3.8 (1.6)	
Sex			0.3
Male	238 (27.0)	3.8 (1.7)	
Female	645 (73.1)	4.0 (1.6)	
Year of study			0.049
Second	315 (35.7)	3.8 (1.7)	
Third	338 (38.3)	4.0 (1.6)	
Fourth	230 (26.0)	4.1 (1.7)	
Having a family member with cardiac diseases			0.09
Yes	260 (29.5)	4.1 (1.6)	
No	623 (70.6)	3.9 (1.7)	
Major			<0.001
Dental technology	192 (21.7)	3.6 (1.6)	
Radiology	168 (19.0)	4.2 (1.9)	
Medical laboratory sciences	141 (16.0)	3.7 (1.5)	
Speech and audiology	113 (12.8)	3.3 (1.4)	
Physical therapy	108 (12.2)	4.8 (1.6)	
Optometry	75 (8.5)	4.0 (1.4)	
Occupational therapy	55 (6.2)	4.5 (1.7)	
Allied dental sciences	31 (3.5)	4.1 (1.6)	

CPR: cardiopulmonary resuscitation; * Student t-test or one-way analysis of variance (ANOVA); SD: Standard Deviation

Furthermore, the knowledge score ranged from one to nine among trained individuals, with 108 students (56.8%) scoring five or more points. In addition, when asked about the last time of training 33.0% had their training recently (< one year), 24.3% past two years, 27.6% in the past three to four years and 15.1% more than five years ago.

Regression analysis

Table 3 summarises the factors included in the regression analyses. Factors significantly associated with higher knowledge scores were previous CPR training (β =0.9; 95%CI: 0.6, 1.1; p<0.001), age (β = 0.1; 95%CI: 0.01, 0.1; p=0.03), fourth-year study level (β =0.4; 95% CI: 0.1, 0.5; p=0.04) and being in the physical therapy, occupational therapy or radiology programs. Moreover, being in the second-year of study and enrolled in dental technology or speech and audiology programs were associated with lower knowledge scores. Having a family member with cardiac disease was not statistically significant (β = 0.2; 95% CI: -0.3, 0.5; p=0.1).

Using a stepwise multivariate regression analysis with backward elimination, previous training remained statistically significant (Adjusted β = 0.6; 95% CI: 0.2, 0.9; p<0.001). Moreover, being in the physical therapy program was positively associated with higher knowledge scores (Adjusted β = 0.5; 95% CI: 0.1, 0.8; p=0.01). On the other hand, lower knowledge scores were associated with speech and audiology (Adjusted β = -0.8; 95% CI: -1.2, -0.5; p<0.001), dental technology (Adjusted β = -0.5; 95% CI: -0.8, -0.3; p<0.001), and medical laboratory sciences programs (Adjusted β = -0.4; 95% CI: -0.7, -0.1; p=0.02).

Table 3 Linear regression analyses of factors associated with CPR knowledge

Characteristic	Univariate regression			Multivariate regression		
	β	P	95% CI	β	P	95% CI
CPR Trained (Ref: No)	0.9	<0.001	0.6, 1.1	0.6	<0.001	0.2, 0.9
Age	0.1	0.03	0.01, 0.1	-	-	-
level						
2nd year	-0.3	0.03	-0.5, -0.02	-	-	-
3rd year	0.03	0.8	-0.2, 0.3	-	-	-
4th Year	0.3	0.04	0.01, 0.5	-	-	-
Family history of cardiac disease (Ref: No)	0.2	0.1	-0.03, 0.5	-		
GPA	0.1	0.2	-0.1, 0.4	-	-	-
Major						
Dental technology	-0.5	0.001	-0.7, -0.2	-0.5	<0.001	-0.8, -0.3
Radiology	0.3	0.03	0.0, 0.6	-	-	-
Medical laboratory sciences	-0.2	0.1	-0.5, -0.1	-0.4	0.02	-0.7, -0.1
Speech and audiology	-0.8	<0.001	-1.0, -0.4	-0.8	<0.001	-1.2, -0.5
Physical therapy	0.9	<0.001	0.6, 1.3	0.5	0.01	0.1, 0.8
Occupational therapy	0.6	0.01	0.1, 1.0	-	-	-
Allied dental sciences	0.2	0.5	-0.4, 0.8	-	-	-
Optometry	0.1	0.7	-0.3, 0.5	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average

Furthermore, table 4 outlines the univariate and multivariate analyses examining the factors associated with knowledge among trained individuals. Time since last training was the only factor associated with CPR knowledge in both analyses. Compared to recent training (< one year), longer times since last training was negatively associated with the knowledge scores.

Table 4: Linear Regression analyses of factors associated with knowledge scores among trained individuals

Characteristic	Univariate regression			Multivariate regression		
	β	P	95% CI	β	P	95% CI
Time since last training						
Recent (<1 year)	Ref	-	-	Ref	-	-
Two years ago	-0.8	0.01	-1.3, -0.2	-0.8	0.006	-1.4, -0.2
Three to four years ago	-1.1	<0.001	-1.6, -0.5	-1.1	<0.001	-1.6, -0.5
>five years	-1.9	<0.001	-2.6, -1.2	-1.9	<0.001	-2.6, -1.2
Level						
2nd year	-0.6	0.04	-1.2, -0.02	-	-	-
3rd year	0.2	0.5	-0.3, 0.6	-	-	-
4th year	0.2	0.3	-0.2, 0.7	-	-	-
Age	0.1	0.1	-0.04, 0.3	-	-	-
GPA	0.3	0.1	-0.1, 0.8	-	-	-

Family history of cardiac disease (Ref: No)	0.1	0.6	-0.4, 0.6	-	-	-
Major						
Radiology	0.5	0.1	0.1, 1.0	-	-	-
Medical laboratory sciences	-0.6	0.1	-1.4, 0.1	-	-	-
Speech and audiology	-1.2	0.01	-2.2, -0.3	-	-	-
Physical therapy	0.8	0.002	0.3, 1.4	-	-	-
Optometry	-0.7	0.2	-1.6, 0.3	-	-	-
Allied dental sciences	-0.9	0.1	-1.8, 0.1	-	-	-
Occupational therapy	0.2	0.5	-0.5, 0.9	-	-	-
Dental technology	-0.4	0.2	-1.1, 0.3	-	-	-

CPR: cardiopulmonary resuscitation; β: coefficient; CI: Confidence Interval; GPA: grade point average; Nationality: Jordanian

DISCUSSION

The study aimed to explore the level of CPR knowledge among AHP students and possible factors that contribute to their knowledge. We recruited a representative sample from eight different majors from the FAMS. Our study shows a poor level of CPR knowledge among AHP students. Surprisingly, this poor knowledge is also observed among the trained group. We also identified an independent association between CPR training and being in the physical therapy**.** On the other hand, lower knowledge scores were associated with speech and audiology, dental technology, and medical laboratory sciences programs. Moreover, among trained individuals, time since last training was the only factor to predict trained individual level of knowledge. To our knowledge, this is the first study to explore the level of knowledge among AHP students in Jordan. This study can guide future research and provide recommendations and be a model to improve the level of CPR Knowledge in Jordan as well as the Middle East and North Africa (MENA) region.

Although the variation is not too high, trained individuals were older than their untrained counterparts. This is due to the characteristics of the included sample (the vast majority with age range 19 – 22 years old); therefore, a small variation will cause a significant difference. This may also be due to the increased likelihood of older student to obtain opportunities for training and study major requirements that involved CPR training.

Higher mean knowledge scores were found in physical therapy, occupational therapy and radiology than those of dental technology and speech and audiology. This can be explained by the fact that physical therapy and occupational therapy curricula include an introduction course that mandates CPR training and evaluation. Furthermore, in the physical therapy program, the curriculum also includes a cardiac rehabilitation course where students have

also mandatory CPR training and evaluation with training being delivered by paramedic program staff. Finally, the radiology program also have a patient-care oriented course which also mandates CPR training.

The majority of participants who did not receive CPR training reported unawareness of training locations and the lack of time as the top barriers. Nevertheless, the majority of participants were willing to be enrolled or repeat CPR training, motivated by their willingness to help people in need and having a personal interest in learning CPR skills.

Despite the differences in populations and survey questions, our results are similar to other studies reporting higher knowledge among trained individuals, despite the poor level of knowledge. [22-25] Aroor et al., in study conducted in South India, reported an overall awareness and knowledge of BLS mean score of 4.16 (SD± 1.40) of a 10 maximum indicating a poor knowledge score among nursing, dental, and medical individuals including undergraduate, internship, and postgraduate groups. However, these knowledge scores based on a survey about BLS knowledge which is not similar to our survey. In addition, the authors found that age, gender, level of training, program of study and previous exposure to basic life support (BLS) were significantly associated with knowledge level. [23] While our regression analysis accounted for most of these factors, only CPR training and being in the physical therapy program were with the only significant predictors of better knowledge. Barriers to learning CPR, in the Aroor et al study, was similar to the top reported barriers in our study being lack of time and unawareness of where these workshops are held. [23]

Furthermore, a study in Pakistan including 250 medical students also reported that medical students with BLS training had higher knowledge (Mean, SD) compared to those untrained. [22] Moreover, Ghanem et al examined the knowledge of CPR among 823 medical university

students reporting 27% of participants who received BLS training. The study also reported similar results where CPR knowledge was associated with previous CPR training, despite their overall poor level of knowledge. The majority of participants were males (88.3% of 824) which is different from our study. In addition, despite the low percentage of female participants, the study reported higher knowledge scores among females ($p < 0.001$). [24]

Other international studies have also reported that trained individuals were more willing and confident to perform bystander CPR. [5 9 10] This may reflect that higher knowledge of CPR is associated with previous training. Our results are in concurrence with other studies reporting that BLS skills deteriorate with time post education and training. [12 13 17] Therefore, continuous education can increase the level of knowledge and optimise CPR performance.

Furthermore, the poor level of knowledge urges designing compulsory and regular training programs/courses or graduation requirements. This is arguably especially important for medical and health care majors, which are supported in recommendations made in numerous reports. [3 22 23 25] Such programs can teach hands-only/compressions only CPR, which is highly recommended by the American Heart Association[4] and was reported to be associated with participants being more willing to perform CPR and higher survival rates.[2]

To overcome the barriers to taking a CPR course, short training workshops (<30 minutes) can also be designed. [26] This can be combined by introducing media, mobile devices, and self-learning videos to expand the number of potential participants who are willing to learn CPR. [5 27] Furthermore, Arabic versions of CPR can be developed and validated for the public in Arabic speaking countries, so students and healthcare professionals can help training larger numbers of the population at life-threating risks.

It might be difficult to train all people in Jordan including Jordanian University students, therefore, it is essential to target high-risk groups and/or staff and students who are highly likely to encounter cardiac arrest patients. This may include training the students who report family members with cardiac diseases, students in health-related programs as well as students in non-medical programs with the likelihood to encounter cases that can benefit from CPR. Moreover, universities can adopt initiatives to increase training rates as well as maintaining these training. This may include train the trainers initiatives, where academic staff and students in health-related programs are trained by professionals to qualify them as trainers. This can be followed and/or accompanied by campaigns to train students and the public. Including professional mandatory CPR training and evaluation in certain courses in different study years may also aid in improving CPR knowledge. In addition, short educational videos can be distributed through university applications and can be a mandatory requirement for students' registration. Furthermore, a work requirement that mandates training in BLS can further improve the level of knowledge among AHP graduates and professionals.

In developed countries, CPR training is delivered to school students; however, this is not available in Jordan. [28 29] Therefore, similar programs can be adopted to train the teachers and students at various cities and schools in Jordan, this will increase the awareness of CPR and improve survival rate. Moreover, global initiatives such as Restart-a-Heart Day held in October 2018, in which JUST participated and trained over 800 students and staff. This initiative was supported by international Liaison Committee on Resuscitation (ILCOR) and trained over 200,000 potential lifesavers.

Although it could be more clinically relevant to display how many students know correct CPR, the aim of this study was to explore how much the FAMS students know about CPR using a 10-points scale. However, future research with different designs can consider measuring the proportion of participants who are able to perform CPR correctly.

The poor level of knowledge found in our study may indicate an inadequate knowledge level among professionals who interact with patients on a daily bases. Further studies are also recommended to examine the professional knowledge and attitude towards CPR in Jordan as well as skill and knowledge retention.

Limitations

The inherent nature of the cross-sectional design of this study and recall bias of CPR training may have affected reporting the association with knowledge. There is no standardised published survey regarding CPR knowledge; however, we adopted our questionnaire based on the AHA 2015 recommendations as well as the relevant literature regarding CPR. [1-4] Moreover, an expert panel designed and reviewed the survey from paramedicine and other allied health science fields. The survey was also piloted to 20 AHP students and modified based on their feedback in an attempt to improve validity and reliability.

There is a paucity of research regarding CPR knowledge among AHP students in general. However, we compared our results to studies including university students with health-related majors including medicine, nursing and any allied health professions, which considered to be comparable to our cohort due to similar study designs and level of questions.

Generalisability

Although a potential gender skew may be questioned, this percentage is representative of the student in FAMS (70% females). This is more likely due to cultural uniqueness in Jordan, as more females are willing to enrol in health-related disciplines compared to males. Therefore, the gender distribution in this study is expected to be observed at other universities with faculties similar to FAMS at JUST as well as the MENA region. However, generalising the findings of our results should consider the inclusion criteria, type of questions, setting, type of participants and the type of outcome measures used in this study. As per the reported barriers of the AHP students, which are considered a highly educated group in the Jordanian population, a poor level of knowledge could also be expected among the public in Jordan. This poor knowledge is also expected due to lack of public initiatives and mandatory training courses in Jordan.

CONCLUSION

There is a poor level of knowledge CPR among AHP students in Jordan. However, higher knowledge scores were associated with previous CPR training as well as more recent training. The study also found that the top barriers were unawareness of training locations and lack of time. Finally, compulsory training courses, shorter training periods, and use of various media devices are recommended to reach wider communities. Various initiatives to increase the awareness of CPR among university students and other population are highly recommended.

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CONFLICT OF INTEREST: The authors declare no conflict of interest.

Data sharing statement: The data sets generated and/or analysed during the current study are not publicly available due to them containing information that could compromise research participant privacy/consent but are available from the corresponding author on reasonable request.

Contribution statement: Dr. Alaa Oteir (AO), conceived the study idea, collected the data, conducted the statistical analyses and drafted the manuscript. AO, Dr. Khader Almahdawai (KA), Dr. Saddam Kanaan (SK), Dr. Mahmoud Alwidyan (MA) and Prof. Brett Williams (BB), have made a considerable contribution to the study design, interpretation, writing and reviewing the manuscript. The final manuscript has been approved by all authors.

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Figure legends

Figure 1. Barriers to CPR training (n=722)

Figure 2 Motivators for CPR training/retraining (n=614; not mutually exclusive)

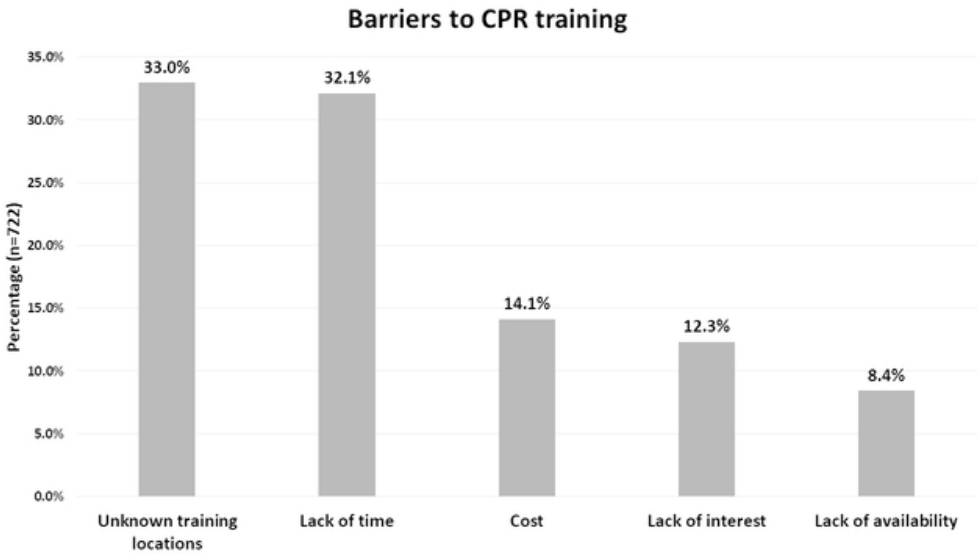

Figure 1. Barriers to CPR training (n=722)

27x15mm (600 x 600 DPI)

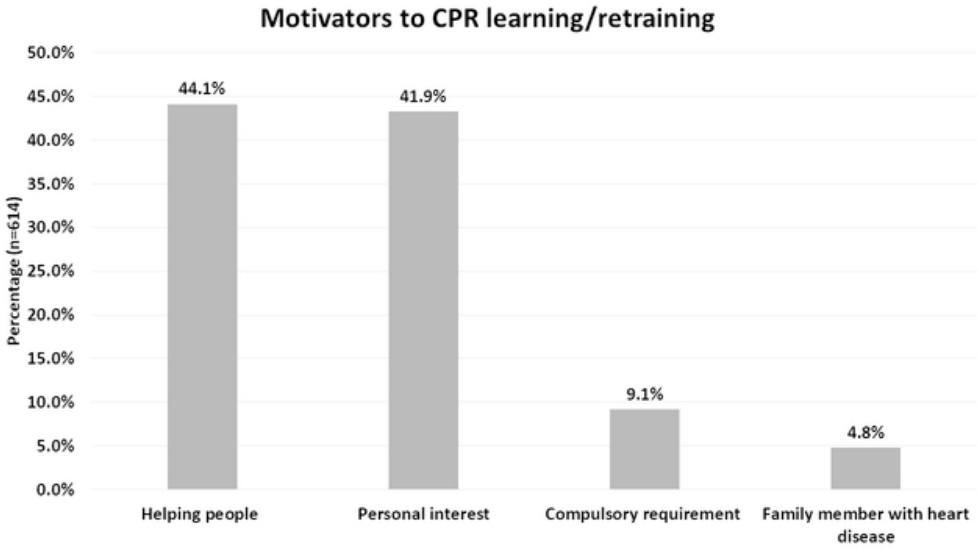

Figure 2 Motivators for CPR training/retraining (n=614; not mutually exclusive)

27x15mm (600 x 600 DPI)

Appendix A: survey questions

Knowledge questions	Answers
1.You were alone and sighted an adult laying on the floor, what would be the most important step to do?	• **Check consciousness and breathing (correct)** • Check pulse • Start compressions immediately • Call for help or emergency number
2.Which of the following is true regarding CPR?	• **CPR Starts with chest compressions** (correct) • CPR starts with mouth to mouth breathing • CPR starts with mouth to mouth and chest compressions simultaneously • Giving a mouth to mouth breathing is more important and superior to chest compression
3.What is the compressions to breathing ratio for an adult patient?	• **30 compression:2 breaths (correct)** • 30 compression:5 breaths • 5 compression:1 breath • 15 compression:1 breath
4.What is the number of compressions per minute for an adult patient?	• **100-120 compressions per minute (correct)** • More than 120 compressions per minute. • 80-100 compressions per minute • 60 – 80 compressions per minute
5.Which of the following is a characteristic of true effective CPR?	• **Allowing full chest recoil after each compression (correct)** • Compression without allowing chest recoil • Compressing fast but not hard • Compressing slowly
6.What is the depth of compression for an adult patient?	• **5 to 6 cm (correct)** • 2 to 3 cm • 3 to 4 cm • At least 6 cm
7.Once confirmed the need for CPR, chest compressions should start within a maximum of	• **10 seconds (correct)** • 5 seconds • 15 seconds • 30 seconds
8.Which of the following is a characteristic of true effective CPR?	• **Pushing (compressing) hard and fast (correct)** • Pushing (compressing) with medium speed • Pushing (compressing) slowly • Pushing (compressing) with medium power
9.What is the emergency Number in Jordan?	• **911 (correct)** • 000 • 119 • 112

10.Sudden loss of consciousness/collapse may indicate a need for CPR.	• **Yes (correct)** • No

Title: **Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	2, 5, 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5 - 7
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9,10
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	9-15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13-16
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.