

RESEARCH ARTICLE

COVID-19 knowledge, attitudes, and practices of United Arab Emirates medical and health sciences students: A cross sectional study

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Abstract

The COVID-19 pandemic is the largest viral pandemic of the 21st century. We aimed to study COVID-19 knowledge, attitudes, and practices (KAP) among medical and health sciences students in the United Arab Emirates (UAE). We performed a cross-sectional study between 2 June and 19 August 2020. The survey was distributed online using Survey Monkey. It was conducted in English and comprised two parts: socio-demographic characteristics, and KAP towards COVID-19. 712 responses to the questionnaire were collected. 90% of respondents (n = 695) were undergraduate students, while 10% (n = 81) were postgraduates. The majority (87%, n = 647) stated that they obtained COVID-19 information from multiple reliable sources. They were highly knowledgeable about the COVID-19 pandemic, but 76% (n = 539) did not recognize its routes of transmission. Medical students were significantly more knowledgeable compared with allied health students ($P < 0.0001$, Mann Whitney U test) but there was no difference in knowledge between undergraduate and postgraduate students ($P = 0.14$, Mann Whitney U test). Medical students thought that more could be done to mitigate the COVID-19 situation compared with the allied health students (66.2% compared with 51.6%, $p = 0.002$ Fisher's Exact test). 63% (n = 431) were worried about getting COVID-19 infection, while 92% (n = 633) were worried that a family member could be infected with the virus. 97% (n = 655) took precautions when accepting home deliveries, 94% (n = 637) had been washing their hands more frequently, and 95% (n = 643) had been wearing face masks. In conclusion, medical and health sciences students in the UAE showed high levels of knowledge and good attitudes and practices towards the COVID-19 pandemic. Nevertheless, they were worried about themselves or their family members becoming infected. Medical students had more knowledge about COVID-19 pandemic which was reflected in their opinion that more can be done to mitigate its effects.

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Abbreviations: SARS-CoV-2, Severe acute respiratory syndrome coronavirus 2; COVID-19, Coronavirus disease 2019; HCW, Healthcare workers; ICU, Intensive care unit; ILO, International Labour Organization; IFAD, The International Fund for Agricultural Development; WHO, World Health Organization; FAO, Food and Agriculture Organization; KAP, knowledge, attitudes, and practices; UAE, United Arab Emirates; UAEU, United Arab Emirates University.

Introduction

COVID-19 pandemic is one of the major global threats of the 21st century. Its virus (SARS-CoV-2) was isolated after causing a cluster of fatal pneumonia cases in Wuhan, China [1]. The pandemic spread swiftly because of the rapid transportation methods with major global impact on physical and mental health and on the economy [2–4]. Currently more than 150 million infected persons and 3 million deaths are attributed to this pandemic [5, 6].

The United Arab Emirates (UAE) was the first country in the Gulf Cooperation Council to report a COVID-19 case (on January 29, 2020) which was linked to Wuhan [7]. In the UAE, more than 450,000 infections and 1,470 deaths had been reported to March 28, 2021 [8]. Due to the initial lack of availability of vaccines at the outset [9], each country adopted various responses to COVID-19 to slow down transmission and to prevent oversaturation of health-care systems. The UAE government issued a set of guidelines and preventive measures to fight the spread of COVID-19, including the closure of borders, educational institutions, and shopping malls; introduction of remote working rules; restriction of public movement; and implementation of personal hygiene measures including using face masks, social distancing, mass screening of asymptomatic cases, and contact tracing [10].

If these measures are to be effective, adherence is essential, and this is influenced by people's knowledge, attitude, and practices (KAP) towards COVID-19 [11, 12]. KAP towards infectious diseases, including acceptance of immunization, are associated with emotional reactions which can affect virus transmission and control [9, 13, 14]. KAP involves a range of beliefs about the causes of the disease, risk factors, identification of symptoms, and available methods of treatment and their consequences [15]. These beliefs come from different sources, including preconceptions concerning similar viral diseases, governmental information, social media and the internet, previous personal experiences, and medical sources. These beliefs may drive preventive behaviours that can vary across different populations. Lack of knowledge or false medical beliefs may carry potential risks [16]. A study from Henan, China, showed that higher levels of information were associated with more positive attitudes towards COVID-19 preventive practices [16]. Perception of risk is important for prevention of infection during pandemics [17–20].

University students can be a source of increased health awareness and health education not only for themselves but also for those around them as they take part in the dissemination of pandemic-related knowledge supporting the prevention and control of the pandemic [21, 22]. Recent studies from Pakistan, Saudi Arabia and Japan have shown that medical students have sufficient knowledge, positive attitudes, and proactive practices during the COVID-19 crisis [23–25].

There are more than 138,000 students in the UAE colleges and universities [26]. From March 2020 their classes were shifted to online learning which was a new learning experience for them [27]. The students received information regarding COVID-19 by online lectures, webinars, university websites, LinkedIn, WhatsApp groups, Facebook pages and Newsletters. A recent study conducted in Sharjah University, UAE, showed that their students demonstrated adequate knowledge, possessed good attitudes, and had low-risk practices towards prevention of COVID-19 [28]. Nevertheless, this study was limited to a single university in UAE and included both medical and non-medical students. We thought it was important to study the KAP towards COVID-19 of medical and allied health sciences students in all UAE. Accordingly, we aimed to evaluate the knowledge of COVID-19, awareness of preventive behaviors, practice, and risk perception among the medical and allied health sciences students in the higher education institutions in the UAE.

Materials and methods

Ethical considerations

Ethical approval was obtained from the UAE University Social Research Committee [UAEU ERS_2020_6119]. Participants' data were anonymized at the point of registration. No personal identifiable data were collected.

Study design

This is a cross-sectional study which was conducted among medical and health sciences students in the UAE between 2nd June and 19th August 2020.

Sample size

We developed a sampling frame including the list of all medical and health sciences colleges and universities in the UAE. As we did not have an access to the information about the number of students at relevant institutions we were not able to estimate a sample size. As the method of data collection was an online-based survey, we used a non-probability sampling approach, namely convenience sampling. The study invitation and survey link were sent directly to the medical and health sciences colleges and universities in the UAE by e-mail and circulated on multiple social media outlets including WhatsApp®. Participants were encouraged to forward the link to their fellow medical and health sciences students and to post it on their social media platforms to maximize enrolment. Accordingly, we could not know the response rate. The study invitation included an introduction, a brief description of the study, and the link to the questionnaire. Respondents were grouped according to their educational institutions.

Questionnaire design

The questionnaire was designed and developed in May 2020 based on two similar published studies [29, 30] and on our own review article which was accepted for publication on 25th March 2020 [3]. These three papers contained early knowledge about the COVID-19 pandemic. Zhong et al study was published on 15th March 2020 and contained 12 questions with true, false, do not know answers [29] while Taghrir et al study [30] was published on 1st April 2020 and contained 15 questions with true/false answers. The attitude and practice sections of Zhong et al [29] were measured using two questions each (agree, disagree, do not know or yes/no). The attitude section of Taghrir et al [30] was measured using two items having a 4-point Likert-type scale while practices were measured by 9 items using a yes/no answer.

Our questionnaire was developed under the direct supervision of an infectious disease expert which was reviewed by another two experienced epidemiologists, one of them is a qualitative researcher. The questionnaire was then piloted among 10 participants for face and content validity. The questions were then modified, refined, rephrased, and restructured to be simpler and clearer. The details of our final questionnaire are attached as [S1 Appendix](#). Since the COVID-19 pandemic is evolving quickly and hence influencing related knowledge and attitudes we decided to depend on face and content validity, as reliability testing was not feasible.

Consent was taken from the participants after providing a brief description of the study, clarifying the voluntary nature of participation, and confirming the declaration of anonymity. The questionnaire was conducted in English, and comprised two parts: socio-demographic characteristics and KAP towards COVID-19. The KAP part consisted of 3 sections with a total of 34 questions, described below.

Knowledge. This section included 12 multiple choice and true/false questions which assessed the participants' knowledge about COVID-19. The items included etiology of the disease, transmission of the virus, symptoms, incubation period, diagnostic tests, treatment options, and prevention. In the knowledge section, respondents were given options to answer true, false, or don't know.

Attitude. This section included 6 questions which assessed the participants' attitudes towards the COVID-19 pandemic using a Likert scale. This was coded as follows: strongly disagree = 1, disagree = 2, undecided = 3, agree = 4, strongly agree = 5. Items included fear of getting infected, stigma around infected individuals, government measures, and participants' confidence in the measures.

Practice. This section included 16 questions which assessed the participants' practices related to COVID-19 using multiple-choice questions, yes/no questions, and a Likert scale. The items were related to practices and compliance with preventative measures and precautions implemented by the government, such as social distancing, wearing face masks, and hand washing.

Statistical analysis

Knowledge level was calculated as follows: incorrect or uncertain responses were given a score of 0, and correct answers were given a score of 1. Choosing a correct answer along with an incorrect answer was given a score of 0.5. The total score for knowledge ranged from 0 to 26, with high scores indicating better knowledge of COVID-19. Poor practices were given a score of 0, and good practices were given a score of 1. Choosing a good practice with a bad practice was given score of 0.5. The total score for practices ranged from 0 to 25, with high scores indicating better COVID-19 practices.

Continuous data were presented as median (range) while categorical data were presented as number (%). Percentages were calculated from the actual available responses. Continuous data (age and scores) did not have a normal distribution, hence nonparametric statistical methods were used to compare different groups as such methods analyse the ranks, do not need a normal distribution, and can be used for small groups. Categorical data of two independent groups were compared using Fisher's Exact test. while continuous data of two independent groups were compared using Mann-Whitney U test [31]. We used the Statistical Package for the Social Sciences (IBM-SPSS version 26, Chicago, IL) for statistical analyses. A p value of < 0.05 was accepted as statistically significant.

Results

A total of 712 responses to the questionnaire were collected. **Table 1** shows the detailed demography of the participants. 90% (n = 695) of respondents were undergraduates, while 10% (n = 81) were postgraduates. The majority of respondents (87%, n = 647) obtained COVID-19 information from multiple sources, 7% (n = 52) obtained it from social media, while the rest 6%, (n = 48) relied on either medical platforms, healthcare professionals, government media briefings, or university newsletters. 406 respondents (57%) attended webinars to learn more about COVID-19.

Table 2 shows the comorbidities and COVID-19 history of the participants. 8% of the participants who were tested for COVID-19 had a positive result. 85% (n = 506) had had a family member or friend who was tested for COVID-19, of which 15% (n = 89) had a positive result.

Knowledge

A total of 712 respondents completed the knowledge section of the survey (**Table 3**). 76% (n = 539) of participants did not recognize the correct routes of transmission of COVID-19,

Table 1. Characteristics of respondents of the KAP survey collected between 2nd June and 19th August 2020.

Variables*		Median or Number	Range or %
Age (years)		20	(16–48)
Gender			
	Male	108	14%
	Female	690	86%
Nationality			
	UAE	480	60%
	Non-UAE	315	40%
Emirate of residence			
	Abu Dhabi	421	54%
	Dubai	125	16%
	Sharjah	94	12%
	Ajman	60	8%
	Ras Al Khaimah	55	7%
	Fujairah	15	2%
	Um Al Quwain	6	1%
Academic affiliation			
	UAE University (CMHS)	247	32%
	Fatima College of Health Sciences	169	22%
	RAK Medical & Health Sciences University	116	15%
	Sharjah University	77	10%
	Mohammed Bin Rashid University	48	6%
	Gulf Medical University	46	6%
	Ajman University	24	3%
	Other Colleges	49	6%
Speciality			
	Medicine	431	56%
	Nursing	117	15%
	Pharmacy	49	6%
	Physiotherapy	45	6%
	Dental	44	6%
	Radiology and Medical Imaging	21	3%
	Biomedical Sciences	20	3%
	Medical Laboratory Technology	17	2%
	Others	29	4%

* All variables are expressed as number (%) except age which is expressed as median (range)

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although the majority of respondents correctly recognized its symptoms, average incubation period, best diagnostic test, and its management (95%, 85%, 89%, 89% and 70% respectively). The majority of the respondents were aware of the COVID-19 preventative measures, including methods to reduce viral spread, isolation of positive cases, N95 mask use limited to health care workers, and the necessity of following preventative precautions among young adults and children (83%, 92%, 84%, and 87% respectively).

There was a highly significant difference in the overall scores representing knowledge on COVID-19 between medical students and allied health students (median (range) 17.5 (8.5–23) score compared with 16.5 (5–22.5), $P < 0.0001$, Mann Whitney U test). This represented a 22% difference of the mean rank which is considered as a practical difference. There was no

Table 2. Comorbidities and COVID-19 history of the KAP survey respondents.

Variable	Number	(%)
Personal chronic condition		
Asthma	28	37%
Diabetes	10	13%
Hypertension	5	7%
Inflammatory bowel disease	3	4%
Migraine	3	4%
Polycystic ovary syndrome	3	4%
Others	24	32%
Personal history of COVID-19		
Tested for COVID-19 = yes	160	92%
Tested positive = yes	13	8%
Household history of COVID-19		
Asymptomatic	16	19%
Quarantined with mild symptoms	57	67%
Admitted to hospital with severe symptoms	6	7%
Admitted to ICU with severe symptoms	3	4%
Died	3	4%

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significant difference in knowledge scores between undergraduate and postgraduate students (median (range) score 17.25 (5–23) compared with 17.5 (7.5–22.5), $P = 0.14$, Mann Whitney U test) (Fig 1).

Attitude

A total of 686 respondents completed the attitudes section of the survey (Table 4). 63% ($n = 431$) of participants were worried about getting COVID-19 infection, while the vast majority (92%, $n = 633$) were worried that a family member could get infected with the virus. 67% ($n = 461$) of the respondents thought that infection with the virus is associated with stigma. 83% ($n = 570$) agreed that the current measures taken by the UAE government are effective in stopping the spread of the infection, and 89% ($n = 614$) were confident that the UAE will be able to stop the spread of the virus. Nevertheless, 60% ($n = 288$) thought that more measures could be implemented such as aggressive screening, full lockdown, further education for the public, monitoring the media, and combatting rumors. Some were opposed to the lockdown and suggested relaxing restrictions.

There were no significant differences in any of the negative attitudes between the medical and allied health students or undergraduate and postgraduate students (Table 5). Nevertheless, the medical students thought that more can be done to mitigate the situation compared with the allied health students (176/266 (66.2%) compared with 112/217 (51.6%), $p = 0.002$ Fisher's Exact test). This difference was not significant between the undergraduate and postgraduate students (261/435 (60%) compared with 27/49 (55.1%), $p = 0.54$ Fisher's Exact test).

Practices

A total of 677 respondents completed the practices section of the survey (Table 6). 60% ($n = 407$) did not attend family gatherings, and did not visit shopping malls, coffee shops, industrial areas, hospitals or COVID-19 facilities for volunteering. 97% ($n = 655$) took precautions when accepting home deliveries, 94% ($n = 637$) had been washing their hands more

Table 3. Responses to the survey on COVID-19 knowledge.

Statement	Correct		Incorrect/ Uncertain		Total*
	n	(%)*	n	(%)*	
COVID-19 is a new disease caused by virus SARS-CoV-2. <i>Answer: True</i>	570	80%	142	20%	712
Which animal is most likely to transmit this virus to human? <i>Answer: Bat, Pangolin, or Civet Cat</i>	633	89%	79	11%	712
SARS-CoV-2 can be transmitted between humans by the following routes? <i>Answer: Respiratory droplet, or surfaces</i>	173	24%	539	76%	712
Which of the following are COVID-19 symptoms? <i>Answer: Fever, Dry cough or with sputum, Shortness of breath, Nausea, Vomiting, diarrhea, Loss of taste or smell, Runny nose</i>	679	95%	33	5%	712
What is the average incubation period of COVID-19? <i>Answer: 7–14 days</i>	602	85%	110	15%	712
What is the best diagnostic test for COVID-19? <i>Answer: RT-PCR</i>	636	89%	76	11%	712
COVID-19 can be treated by using the following: <i>Answer: Antiviral, Anti-malarial, or Convalescent plasma transfusion</i>	500	70%	212	30%	712
Which of the following can reduce the spread of COVID-19? <i>Answer: Social distancing, Self-isolation, Wearing face masks, or Avoiding crowded places</i>	591	83%	121	17%	712
People who are asymptomatic and COVID-19 test positive must stay at home until they are free of the infection: <i>Answer: True</i>	653	92%	59	8%	712
Who should wear N95 masks? <i>Answer: Healthcare professionals who are dealing with COVID-19 patients</i>	601	84%	111	16%	712
Persons with COVID-19 cannot transmit the virus to others when a fever is not present. <i>Answer: False</i>	635	89%	77	11%	712
It is not necessary for children and young adults to take measures to prevent infection from COVID-19 virus. <i>Answer: False</i>	616	87%	96	13%	712

Percentages may not total 100 because of rounding

*Percentages were calculated out of 712, which is the total number of respondents who completed the knowledge items

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frequently, and 95% (n = 643) had been wearing face masks. Meanwhile, out of 666 respondents almost all followed curfew timings set by the UAE government (99% (n = 658)). Overall, most medical students and allied health sciences students followed proper practices.

There was no significant difference in the COVID-19 practice scores between medical students and allied health students (median (range) 15 (0–25) score of compared with 15 (0–25), P = 0.15, Mann Whitney U test, and between undergraduate and postgraduate students (median (range) score of 15 (0–25) compared with 15.5 (0–24), P = 0.3, Mann Whitney U test) (Fig 2).

Discussion

Our study has shown that the majority of medical and allied health students at UAE were knowledgeable about COVID 19, worried about getting infected or having a member of their family infected, and had proper practices and precautionary measures for preventing COVID-19. Nevertheless, medical students were more knowledgeable about COVID-19 and thought that more can be done to mitigate the COVID-19 situation compared with allied health students. There was no difference in knowledge, attitudes, or practices towards COVID-19 pandemic between undergraduate and postgraduate students.

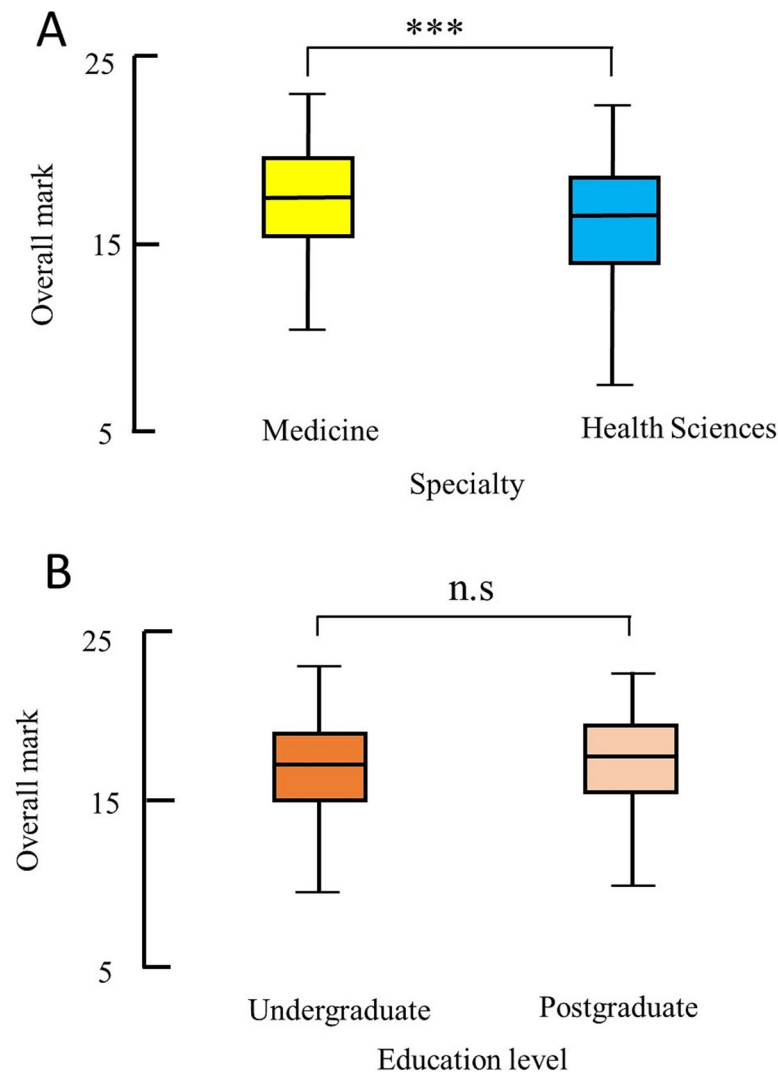


Fig 1. Box-and-whiskers plot of overall score for knowledge comparing medical students with allied health students (A) and undergraduate students with postgraduate students (B). The box represents the 25th to the 75th percentile IQR. The horizontal line within each box represents the median. *** = $p < 0.0001$, Mann-Whitney U test, ns = non significant.

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A recent study of Sharjah University students [28] compared COVID19-related KAP between students of health-related and non-health related majors. Similar to our study, it was carried out during the early period of the pandemic. Students of health-related majors had higher knowledge about the COVID-19 pandemic and used face masks more compared with students of non-health related majors, despite both groups having the same attitudes [28]. A study from 10 universities in China reported that knowledge of COVID-19 was significantly higher in public universities and among medical majors compared with in private colleges and among non-medical majors [22]. In contrast other studies from Japan [25] and India [32] did not show any differences between medical and non-medical students. The high knowledge about COVID-19 among medical and allied health students in the UAE is similar to findings reported from Japan [25], Saudi Arabia [24], Portugal [33], and Pakistan [23] (96%, 86%, 82%, 72% respectively). These studies used different sets of questions to explore the KAP among

Table 4. Responses to the survey on COVID-19 attitude.

Attitudinal Statement	Strongly disagree		Disagree		Undecided		Agree		Strongly agree		Total*
	n	(%)*	n	(%)*	n	(%)*	n	(%)*	n	(%)*	
Attitude with negative feeling											
You are worried that you will get COVID-19	40	6%	151	22%	64	9%	330	48%	101	15%	686
You are worried that a family member can get infected with this virus	8	1%	29	4%	16	2%	303	44%	330	48%	686
Infection with the virus is associated with stigma	53	8%	118	17%	54	8%	300	44%	161	23%	686
Attitude with positive feeling											
The current measures taken by the UAE government are effective in stopping the spread of the infection	16	2%	57	8%	43	6%	295	43%	275	40%	686
You are confident that the UAE will be able to stop the spread of the virus	4	1%	27	4%	41	6%	263	38%	351	51%	686

Percentages may not total 100 because of rounding

*Percentages were calculated out of 686, which is the total number of respondents who completed the Attitude items

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students; study populations are variable; and sampling techniques are different, although most of them were carried out early in the pandemic. Studies on medical students found that they generally had good knowledge about COVID-19, although this was less in preclinical years compared with clinical years [23, 34]. Medical students are commonly asked for medical advice from their family members which prompts them to learn more about COVID-19 [35, 36].

The high level of knowledge about COVID-19 among medical and allied health students in the UAE may be attributed to their access to multiple reliable medical platforms, healthcare professionals, government media briefings, and university newsletters. These sources may have increased the existing knowledge of these students. It may also be related to the training many of them had received as volunteers in the healthcare system [37]. The majority of our respondents were aware of COVID-19 symptoms, the incubation period, diagnostic testing, management, and the preventative measures. However, only 24% in our study correctly recognized the route of COVID-19 transmission compared with other studies in which

Table 5. Responses to the survey on COVID-19 attitude comparing medical students with allied health students and undergraduate with postgraduate student.

Attitude with negative feeling	Medical		Allied health		p	Undergraduate		Postgraduate		p
	Strongly agree/agree	Strongly disagree/disagree	Strongly agree/agree	Strongly disagree/disagree		Strongly agree/agree	Strongly disagree/disagree	Strongly agree/agree	Strongly disagree/disagree	
	n (%)	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	n (%)	
Attitude with negative feeling										
You are worried that you will get COVID-19	239 (67.9)	113 (32.1)	192 (71.4)	77 (28.6)	0.38	381 (68.5)	175 (31.5)	50 (75.8)	16 (24.2)	0.26
You are worried that a family member can get infected with this virus	366 (95.6)	17 (4.4)	266 (93)	20 (7)	0.17	567 (94.5)	33 (5.5)	66 (94.3)	4 (5.7)	0.99
Infection with the virus is associated with stigma	259 (73)	96 (27)	201 (72.8)	75 (27.2)	0.99	413 (73.4)	150 (26.6)	48 (69.6)	21 (30.4)	0.57
Attitude with positive feeling										
The current measures taken by the UAE government are effective in stopping the spread of the infection	323 (88)	44 (12)	246 (89.5)	29 (10.5)	0.62	508 (88.3)	67 (11.7)	62 (91.2)	6 (8.8)	0.69
You are confident that the UAE will be able to stop the spread of the virus	348 (96.4)	13 (3.6)	265 (93.6)	18 (6.4)	0.14	549 (95.1)	28 (4.9)	65 (95.6)	3 (4.4)	0.99

*Percentages were calculated out of 686, which is the total number of respondents who completed the Attitude items

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Table 6. Responses to the survey on COVID-19 practices.

Practice Statement	Good Practice		Bad Practice		Total
	n	(%)	n	(%)	
Have you visited any of the following places? Shopping mall, Supermarkets, Family gatherings, coffee shops, industrial areas, hospitals for treatment, or COVID-19 facilities for volunteering	407	60%*	270	40%*	677
Do you take precautions when accepting home deliveries?	655	97%*	22	3%*	677
Have you been washing your hands more frequently?	637	94%*	40	6%*	677
Have you been wearing face masks?	643	95%†	33	5%†	676
Do you follow the curfew timings set by the UAE government?	658	99%‡‡	8	1%‡‡	666
Did you discuss COVID-19 with anyone since the pandemic started?	664	99.7%‡‡	2	0.3%‡‡	666

Percentages may not total 100 because of rounding

*Percentages were calculated out of 677, which is the total number of respondents who completed that practice item

†Percentages were calculated out of 676

‡‡ Percentages were calculated out of 666

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undergraduate students were quite knowledgeable about the route of transmission [22, 23]. COVID-19 is transmitted by respiratory droplets; however, airborne transmission may be possible during a medical procedure that generates aerosols [38]. This lack of knowledge was unexpected, given that the majority of our respondents had access to freely available medical resources for this information.

The majority of our participants had followed proper practices and precautionary measures against COVID-19. 60% did not visit shopping malls, attend family gatherings, or go to coffee shops, industrial areas and hospitals; and the majority reported good preventative practices including hand washing, wearing face masks, and abiding by curfew timings. These findings could be attributed to the strict lockdown at the time when the survey was launched, access to trusted medical resources, and training in medical fields. These results are similar to those reported among undergraduate medical students in China, Pakistan, and Iran [22, 23, 31].

The participants in our study reported both negative and positive feelings regarding the pandemic, and the majority were worried that they or a member of their family might get infected. It is important to note that this study was conducted during a period of rapid increase in COVID-19 cases in the UAE. Most of the participants were confident that the UAE will be able to stop the spread of the virus. They also believed that the current measures taken by the UAE government were effective in stopping the spread of the infection although more can be done. This positive attitude can be explained by the drastic measures taken by the UAE government to contain the spread of the virus [39].

Limitations

We have to acknowledge that our study has certain limitations. *First*, this study was conducted using an online survey and mass web-based invitation, so our response rate is unknown. The respondents were predominantly females and medical students. Consequently, the results of the questionnaire all depended on the participants self-reported behaviors, with no means of confirming whether the responses were exaggerated because of social desirability and selection bias. *Second*, this study was begun in the early stages of the pandemic, when the UAE was under lockdown, and continued for a while after the restrictions were lifted. Since then, more information about the pandemic has been published and public health measures in the UAE have changed. Thus, the results of the study may not represent the current COVID-19 KAP of

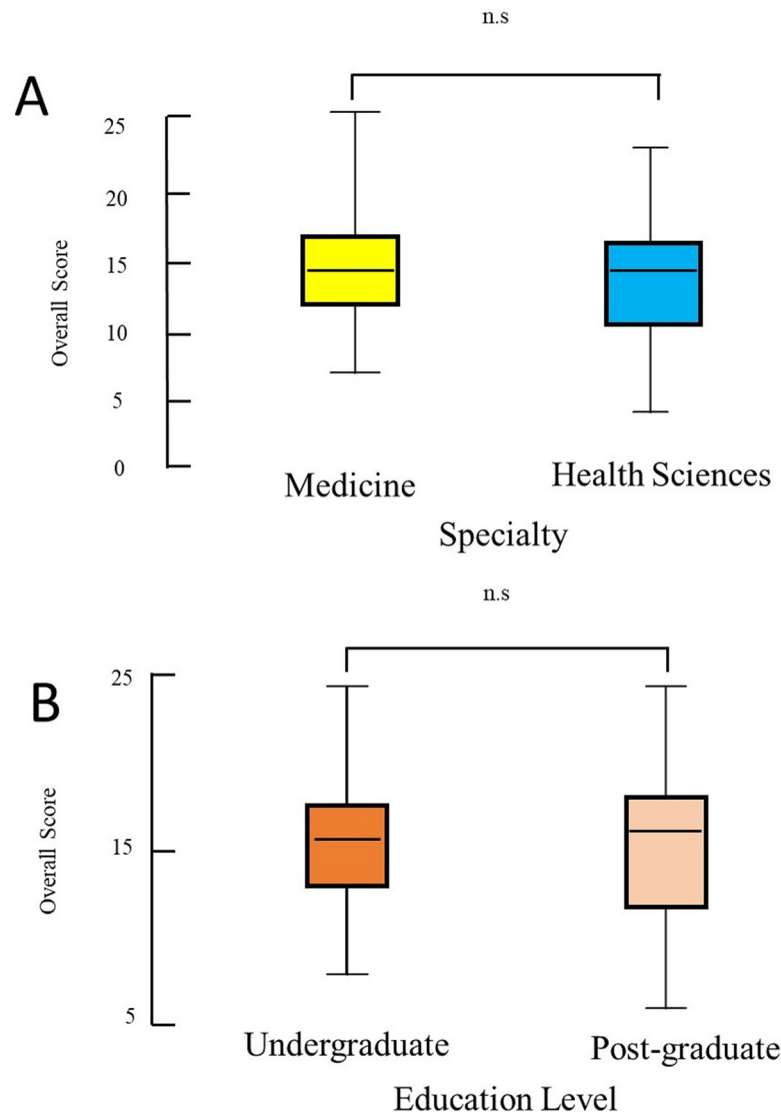


Fig 2. Box-and-whiskers plot of overall score of practices towards COVID-19 comparing medical students with allied health students (A) and undergraduate students with postgraduate students (B). The box represents the 25th to the 75th percentile IQR. The horizontal line within each box represents the median, ns = non significant.

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medical and health sciences students. *Finally*, we did not test the reliability of our questionnaire, depending mainly on face and content validity. Nevertheless, research methodology in crisis situations differs from ordinary situations. We were keen to collect information to help us in our disaster planning for mitigation despite some shortcomings in the methodology [3, 4]. A disaster is defined as “a situation in which available resources are insufficient for immediate need of medical care” [40]. COVID-19 epidemic is a disaster of the highest nature [41]. Research methods and ethics during disasters must be adapted quickly to accommodate the situation so that that mitigation can be achieved, and lessons learned can be carried for the future [42, 43]. The rapidly evolving situation of the COVID-19 pandemic, with its concomitant changes in knowledge and practices, made it difficult to assess the reliability of our

questionnaire in a routine way especially in the knowledge section, as our understanding of COVID-19 was continuously changing.

Conclusions

Medical and health sciences students in the UAE showed high levels of knowledge, good attitudes, and good practices towards the COVID-19 pandemic. Nevertheless, they were worried about infection both of themselves and their family members. Medical students were more knowledgeable about COVID-19 and thought that more can be done to mitigate the COVID-19 situation compared with allied health students.

Supporting information

S1 Appendix.

(PDF)

S1 Data.

(XLSX)

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References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med.* 2020; 382:727–733. <https://doi.org/10.1056/NEJMoa2001017> PMID: 31978945
2. World Health Organization. Coronaviruses (COVID-19) 2020. 12 October 2020. [Cited 2021 Jan 8] Available from <https://www.who.int/news-room/q-a-detail/coronavirus-disease-covid-19>
3. Khan G, Sheek-Hussein M, Al Suwaidi AR, Idris K, Abu-Zidan FM. Novel coronavirus pandemic: A global health threat. *Turk J Emerg Med.* 2020; 20:55–62. <https://doi.org/10.4103/2452-2473.285016> PMID: 32587923
4. Sheek-Hussein M, Abu-Zidan FM, Stip E. Disaster management of the psychological impact of the COVID-19 pandemic. *Int J Emerg Med.* 2021; 14:19. <https://doi.org/10.1186/s12245-021-00342-z> Available from <https://intjem.biomedcentral.com/articles/10.1186/s12245-021-00342-z> PMID: 33761863
5. Douglas M, Katikireddi SV, Taulbut M, McKee M, McCartney G. Mitigating the wider health effects of covid-19 pandemic response. *BMJ.* 2020 Apr 27; 369:m1557. <https://doi.org/10.1136/bmj.m1557> Available from <https://www.bmj.com/content/369/bmj.m1557.long> PMID: 32341002
6. WorldOMeter COVID-19 Coronavirus pandemic. [Cited 2021 April 29] Available from <https://www.worldometers.info/coronavirus/>
7. Turak N. First Middle East cases of coronavirus confirmed in the UAE. CNBC. 2020 Jan 29. [Cited 2020 June 1] Available from <https://www.cnbc.com/2020/01/29/first-middle-east-cases-of-coronavirus-confirmed-in-the-uae.html>
8. Abu Dhabi Public Health Centre, Department of Health, UAE. Abu Dhabi Public Health Centre. Scientific Research Monitoring on COVID-19; Issue 411, 28th March 2021; Page 9. [Cited 2021 April 1] Available from <https://www.doh.gov.ae/ar/covid-19/Healthcare-Professionals/Scientific-Publication>
9. Sheek-Hussein M, Abu-Zidan FM. COVID-19 Vaccine: Hope and reality. *Afr Health Sci* 2020; 20: 1507–1509.
10. The United Arab Emirates' Government portal. 2019 novel coronavirus (COVID-19). [Cited 2021 April 1] Available from <https://u.ae/en/information-and-services/justice-safety-and-the-law/handling-the-covid-19-outbreak/2019-novel-coronavirus>
11. Ajilore K, Atakiti I, Onyenankeya K. College students' knowledge, attitudes and adherence to public service announcements on Ebola in Nigeria: Suggestions for improving future Ebola prevention education programmes. *Health Education Journal.* 2017; 76:648–660. <https://doi.org/10.1177/0017896917710969> Available from <https://journals.sagepub.com/doi/abs/10.1177/0017896917710969>
12. Tachfouti N, Slama K, Berraho M, Nejari C. The impact of knowledge and attitudes on adherence to tuberculosis treatment: a case-control study in a Moroccan region. *Pan Afr Med J.* 2012; 12:52 Available from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3428172/pdf/PAMJ-12-52.pdf> PMID: 22937192
13. Mujibur Rahaman M, Siddiqi UR, Sabuj AAM, Ahmed BN, Tahmina S, Faruque MR et al. Knowledge, attitude, and practice of a local community towards the prevention and control of rabies in Gaibandha, Bangladesh. *J Adv Vet Anim Res.* 2020; 7:414–420. <https://doi.org/10.5455/javar.2020.g436> PMID: 33005666
14. Person B, Sy F, Holton K, Govert B, Liang A; National Center for Infectious Diseases/SARS Community Outreach Team. Fear and stigma: the epidemic within the SARS outbreak. *Emerg Infect Dis.* 2004; 10:358–63. <https://doi.org/10.3201/eid1002.030750> PMID: 15030713
15. Szymona-Palkowska K, Janowski K, Pedrycz A, Mucha D, Ambroży T, Siermontowski P et al. Knowledge of the Disease, Perceived Social Support, and Cognitive Appraisals in Women with Urinary Incontinence. *Biomed Res Int.* 2016; 2016:3694792. <https://doi.org/10.1155/2016/3694792> Available from <https://downloads.hindawi.com/journals/bmri/2016/3694792.pdf> PMID: 28097132
16. Zhang M, Zhou M, Tang F, Wang Y, Nie H, Zhang L et al. Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. *J Hosp Infect.* 2020; 105:183–187. <https://doi.org/10.1016/j.jhin.2020.04.012> PMID: 32278701
17. Corrin T, Waddell L, Greig J, Young I, Hierlihy C, Mascarenhas M. Risk perceptions, attitudes, and knowledge of chikungunya among the public and health professionals: a systematic review. *Trop Med Health.* 2017; 45:21. <https://doi.org/10.1186/s41182-017-0061-x> Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5582396/pdf/41182_2017_Article_61.pdf PMID: 28878549
18. Janjua NZ, Razaq M, Chandir S, Rozi S, Mahmood B. Poor knowledge—predictor of nonadherence to universal precautions for blood borne pathogens at first level care facilities in Pakistan. *BMC Infect Dis.* 2007 Jul 24; 7:81. <https://doi.org/10.1186/1471-2334-7-81> Available from <https://bmcinfectdis.biomedcentral.com/articles/10.1186/1471-2334-7-81> PMID: 17650331

19. Lau JT, Kim JH, Tsui H, Griffiths S. Perceptions related to human avian influenza and their associations with anticipated psychological and behavioral responses at the onset of outbreak in the Hong Kong Chinese general population. *Am J Infect Control*. 2007; 35:38–49. <https://doi.org/10.1016/j.ajic.2006.07.010> PMID: 17276790
20. Smith RD. Responding to global infectious disease outbreaks: lessons from SARS on the role of risk perception, communication and management. *Soc Sci Med*. 2006; 63:3113–23. <https://doi.org/10.1016/j.socscimed.2006.08.004> PMID: 16978751
21. Ferdous MZ, Islam MS, Sikder MT, Mosaddek ASM, Zegarar-Valdivia JA, Gozal D. Knowledge, attitude, and practice regarding COVID-19 outbreak in Bangladesh: An online-based cross-sectional study. *PLoS One*. 2020; 15:e0239254. <https://doi.org/10.1371/journal.pone.0239254> Available from <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0239254> PMID: 33035219
22. Peng Y, Pei C, Zheng Y, Wang J, Zhang K, Zheng Z, et al. A cross-sectional survey of knowledge, attitude and practice associated with COVID-19 among undergraduate students in China. *BMC Public Health*. 2020 Aug 26; 20(1):1292. <https://doi.org/10.1186/s12889-020-09392-z> Available from <https://bmcpublihealth.biomedcentral.com/articles/10.1186/s12889-020-09392-z> PMID: 32847554
23. Noreen K, Rubab ZE, Umar M, Rehman R, Baig M, Baig F. Knowledge, attitudes, and practices against the growing threat of COVID-19 among medical students of Pakistan. *PLoS One*. 2020 Dec 11; 15(12):e0243696. <https://doi.org/10.1371/journal.pone.0243696> Available from <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0243696> PMID: 33306712
24. Aldukhayel A, Alhomidani RJA, Almazayad NS, AlHindi HA, Alsudairi HA. Knowledge, attitude, and practices associated with COVID-19 among university students: a cross-sectional survey in Qassim Region, Saudi Arabia. *International Journal of Medicine in Developing Countries* 2020; 4: 1554–1560. <https://doi.org/10.24911/IJMDC.51-1597038674> Available from <https://ijmdc.com/fulltext/51-1597038674.pdf>
25. Hatabu A, Mao X, Zhou Y, Kawashita N, Wen Z, Ueda M, et al. Knowledge, attitudes, and practices toward COVID-19 among university students in Japan and associated factors: An online cross-sectional survey. *PLoS One*. 2020; 15:e0244350. <https://doi.org/10.1371/journal.pone.0244350> Available from <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0244350> PMID: 33347488
26. Authority Scholarships. Best universities in United Arab Emirates for international students. 18 January 2021. [Cited 2021 April 21] Available from <https://authoritiescholarships.com/best-universities-united-arab-emirates/>
27. The United Arab Emirates' Government portal. Distance Learning in Times of COVID-19 -. [Cited 2021 April 1] Available from <https://u.ae/en/information-and-services/education/distance-learning-in-times-of-covid-19>.
28. Hasan H, Raigangar V, Osaili T, Neinavaei NE, Olaimat AN, Aolymat I. A Cross-Sectional Study on University Students' Knowledge, Attitudes, and Practices Toward COVID-19 in the United Arab Emirates. *Am J Trop Med Hyg*. 2021; 104:75–84. <https://doi.org/10.4269/ajtmh.20-0857> Available from <https://www.ajtmh.org/view/journals/tpmd/104/1/article-p75.xml> PMID: 33236710
29. Zhong BL, Luo W, Li HM, Zhang QQ, Liu XG, Li WT, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *Int J Biol Sci*. 2020; 16:1745–1752. <https://doi.org/10.7150/ijbs.45221> Available from <https://www.ijbs.com/v16p1745.htm> PMID: 32226294
30. Taghrir MH, Borazjani R, Shiraly R. COVID-19 and Iranian Medical Students; A Survey on Their Related-Knowledge, Preventive Behaviors and Risk Perception. *Arch Iran Med*. 2020; 23:249–254. <https://doi.org/10.34172/aim.2020.06> Available from: <http://www.aimjournal.ir/Article/aim-15530> PMID: 32271598
31. Munro BH. Selected nonparametric techniques. In Munro B.H., editor. *Statistical methods for health care research*. 4th ed. New York: Lippincott. 2001; pp 97–121.
32. Prasad Singh J, Sewda A, Shiv DG. Assessing the Knowledge, Attitude and Practices of Students Regarding the COVID-19 Pandemic. *Journal of Health Management*. 2020; 22:281–290. <https://doi.org/10.1177/0972063420935669> Available from <https://journals.sagepub.com/doi/full/10.1177/0972063420935669>
33. Alves RF, Samorinha C, Precioso J. Knowledge, attitudes and preventive behaviors toward COVID-19: a study among higher education students in Portugal. *Journal of Health Research*, 2020 Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/JHR-07-2020-0254> Available from <https://www.emerald.com/insight/content/doi/10.1108/JHR-07-2020-0254/full/html>
34. Khasawneh AI, Humeidan AA, Alsulaiman JW, Bloukh S, Ramadan M, Al-Shatanawi TN, et al. Medical Students and COVID-19: Knowledge, Attitudes, and Precautionary Measures. A Descriptive Study From Jordan. *Front Public Health*. 2020; 8:253. <https://doi.org/10.3389/fpubh.2020.00253> Available from <https://www.frontiersin.org/articles/10.3389/fpubh.2020.00253/full> PMID: 32574313

35. Jairoun A, Hassan N, Ali A, Jairoun O, Shahwan M. Knowledge, attitude and practice of antibiotic use among university students: a cross sectional study in UAE. *BMC Public Health*. 2019; 19:518. <https://doi.org/10.1186/s12889-019-6878-y> Available from <https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-6878-y> PMID: 31060543
36. Plaster AN, Painter JE, Tjersland DH, Jacobsen KH. University Students' Knowledge, Attitudes, and Sources of Information About Zika Virus. *J Community Health*. 2018; 43:647–655. <https://doi.org/10.1007/s10900-017-0463-z> PMID: 29318503
37. The United Arab Emirates' Government portal. Volunteering to fight COVID-19. [Cited 2021 January 2]. Available from: <https://u.ae/en/information-and-services/justice-safety-and-the-law/handling-the-covid-19-outbreak/volunteering-to-fight-covid-19>
38. De Simone B, Chouillard E, Sartelli M, Biffi WL, Di Saverio S, Moore EE et al. The management of surgical patients in the emergency setting during COVID-19 pandemic: the WSES position paper. *World J Emerg Surg*. 2021; 16:14. Available from <https://wjeb.biomedcentral.com/track/pdf/10.1186/s13017-021-00349-0.pdf> PMID: 33752721
39. National Emergency Crisis and Disasters Management Authority. Coronavirus (COVID-19) Updates [Cited 2020 December 24]. Available from: <https://covid19.ncema.gov.ae/en/News/Details/1333>
40. Lennquist S. Major incidents: Definitions and demands on the health-care system. *Medical Responses to Major Incidents and Disasters A Practical Guide for Medical Staff*. In: Lennquist S, editor. 1st ed. London: Springer; 2012. pp. 1–7. <https://doi.org/10.1007/s00068-012-0183-0> PMID: 26815822
41. Coccolini F, Sartelli M, Kluger Y, Pikoulis E, Karamagioli E, Moore EE et al. COVID-19 the showdown for mass casualty preparedness and management: the Cassandra Syndrome. *World J Emerg Surg*. 2020; 15:26. <https://doi.org/10.1186/s13017-020-00304-5> Available from <https://wjeb.biomedcentral.com/articles/10.1186/s13017-020-00304-5> PMID: 32272957
42. Behbehani A, Abu-Zidan F, Hasaniya N, Merei J. War injuries during the Gulf War: experience of a teaching hospital in Kuwait. *Ann R Coll Surg Engl*. 1994; 76:407–11. PMID: 7702326
43. Abu-Zidan FM. Dramatic outcome of a "friendly fire". *Surgery*. 2016; 160:1422–1423. <https://doi.org/10.1016/j.surg.2016.06.047> PMID: 27524429