




The impact of the early stages of the COVID-19 pandemic on academic studies, clinical training, and their opinion on vaccination among radiography students

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ABSTRACT

Objectives: Since its inception, the COVID-19 pandemic has generated challenges for healthcare professions and educational institutions worldwide. This study aimed to investigate the effect of COVID-19 on radiography students' education in Jordan.

Method: A cross-sectional online survey was conducted during the initial COVID-19 lockdown period (31 March to 30 May 2020). All diagnostic radiography year groups at governmental universities (the Hashemite University, Al-Hussein Bin Talal University, and Jordan University of Science and Technology) were invited to complete the anonymous survey in Jordanian using Microsoft Forms.

Results: There were 417 responses. Findings showed that Jordan's radiography students' education has been significantly impacted by the COVID-19 epidemic. The majority of survey participants were not convinced the online learning platforms were user-friendly. Comparing remote teaching versus face-to-face instruction, 51% of participants had difficulty concentrating. Access to clinical placements was the biggest issue raised; 86% of respondents stated that their clinical experience differed from what was outlined in the curriculum. 42% of the students were in favor of receiving the COVID-19 vaccines.

Conclusions: Clinical radiography education in Jordan has been significantly impacted by the COVID-19 pandemic. The availability of necessary facilities for online training, the efficiency of the online platforms, and motivation to learn were the significant issues. The adoption of blended learning strategies and the use of simulation to enhance practical placement chances need to be taken into consideration when developing future training curricula and responses to pandemics.

Keywords: COVID-19 pandemic, student radiographers, quality of educational process, radiography education

INTRODUCTION

The SARS-CoV-2 'coronavirus' has spread very rapidly over many countries around the world, producing a wave of acute infectious pneumonia. The World Health Organization considered this virus (COVID-19) a public health emergency [1], and almost every country applied public health measures to reduce transmission [1]. COVID-19 has considerably affected academic preparations internationally; this has led to many universities stopping face-to-face education, closing classrooms and laboratories, and ceasing clinical rotations to try and minimize the spread of the virus. Nearly 1.725 billion students have been affected by the closure of educational facilities in response to the outbreak [2]. Due to this abrupt change in the method of delivering education, decision-makers and educators started investigating opportunities, tools, and resources for converting face-to-face teaching activities to those based online or delivered remotely.

On March 15, 2022, the Hashemite Kingdom of Jordan's Prime Minister issued an order suspending academic activities at universities and schools. In preparation for a curfew to begin on March 23rd, 2020, under the supervision of Jordan's military force and National Defense Law, the order mandated closing mosques and churches, restricting access to national borders, and suspending all incoming and outgoing aircraft [3]. To address these challenges within education, the Ministry of Higher Education and Scientific Research released new suggestions for switching to online teaching activities within universities. In Jordan, three central government universities provide a bachelor's degree in radiological and medical imaging. These curricula require students to study for four years and focus on basic science and clinical practice. Clinical practice starts at the end of the second year and is provided by leading hospitals in Jordan and other peripheral hospitals.

New platforms for remote study have been developed, making online study considerably simpler [4]. Google and Microsoft announced the platforms Google Meet and Microsoft

Teams, respectively in 2017 establishing a new era of widespread virtual meetings [5]. The use of online e-learning tools like Google Classroom and Moodle made it possible to share study materials, facilitate discussions, and provide a platform for student-lecturer meetings. Online education can help reduce costs, is environmentally friendly, and allows for the creation of more dynamic learning environments by saving up to 60% of traditional learning time [4-7].

The COVID-19 pandemic provided an opportunity to experience a new method of remote teaching using online learning for all courses, without exception. When delivering remote learning, it is important to comprehend the preferences of the students in order to involve them in the process of development and provide the most satisfying and dependable outcomes that strike a balance between the students' preferences and the teaching quality.

At the time of conducting this study, there were no reports from Jordanian educational institutions on how the COVID-19 pandemic had affected radiography students. Numerous studies in the literature have examined the effects of the pandemic in various disciplines and other nations, with a primary focus on the physiological effects [8-10]. This study aims to explore and report the impact of the COVID-19 pandemic among undergraduate BSc radiography students in Jordan during the initial COVID-19 pandemic outbreak. The students' opinions on taking the vaccines and their effect on their studies were further evaluated. This would be an excellent chance for students to consider their learning and suggest whether they need more assistance from the university.

METHOD

The effect of COVID-19 on student radiographers and their clinical training was examined using an online, anonymous survey consisting of 35 questions. Three main governmental universities (the Hashemite University [HU], Al-Hussein Bin Talal University [HBT], and Jordan University of Science & Technology [JUST]) were included in this study. Students received an anonymous survey link in Jordanian using Microsoft Forms. Data were collected over two months during the initial lockdown period (31 March to 30 May 2020). The inclusion criteria included any undergraduate radiography student who experienced online teaching during the COVID-19 pandemic in Jordan. The survey was designed to be completed within 10 minutes. There were no incentives for completing the survey. The survey asked for information on demographics, such as the student's age, training country and academic status. The survey was divided into seven main sections. The first section provided participant information, which included the lead researcher's contact information and an explanation of the study's purpose. Demographic data was requested in the second section. The third involved general questions about the relationship between the coronavirus and the education process. The fourth evaluated education during the pandemic.

Table 1. Demographic characteristics of the study respondents

Variable	Category	n	%
Gender	Male	120	28.7
	Female	297	71.2
Age (years)	18-23	402	96.4
	24-30	13	3.1
	>30	2	0.5
University	HU	265	63.5
	JUST	60	14.4
	HBT	92	22.1
Year of education	First year	62	14.9
	Second year	139	33.3
	Third year	104	24.9
	Fourth year	105	25.2
	>4 years	7	1.7

The fifth sought the opinion of students about hybrid education (online and face-to-face education). The sixth sought general information about the uptake of the COVID-19 vaccine and the resultant effect on education and training. Finally, information regarding the radiological diagnosis of the coronavirus.

Students received periodic reminders and a survey invitation through Microsoft Forms. Participation was voluntary, and a link was sent to the undergraduate students. To maximize the response rate, the electronic form was available for an eight-week period. E-mail reminders were sent to students. The Microsoft Forms tool automatically gathered student responses and summarized the data. To provide a more graphical representation of the data, Microsoft Excel was used for further analysis.

RESULTS

Demographics

A total of 417 questionnaires were completed. **Table 1** outlines the demographics of the respondents. 28.8% of participants were male and 71.2% were female. Most of the participants (96.4%) ranged in age from 18 to 32 years. Second year students (33.3%) were the most likely to have participated in this study, and most students were from HU (63.5%).

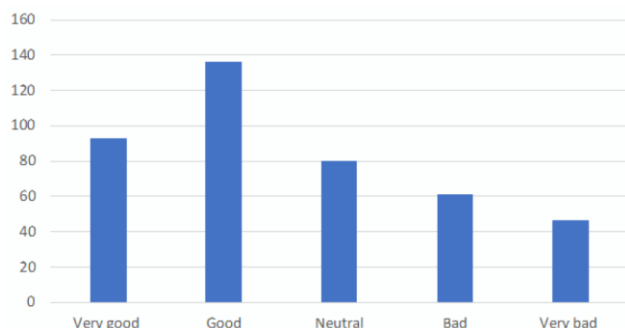
Table 2 presents the data regarding the relationship between COVID-19 and education. Most students (44.0%) agreed that there is a relationship between COVID-19 and educational activities. 265 of the students agreed that online learning affected their understanding of topics. Most students (85.5%) found that COVID-19 required a change in their training from what was originally described in the curriculum. The results showed that most students worried about being a radiographers and the impact of distance learning. 54.5% found their assessment affected.

Table 2. Participant responses to general questions about the relationship between COVID-19 & education (n [%])

Question	Strongly agree	Agree	Disagree	Strongly disagree
Is there a relationship between COVID-19 and educational activities?	184 (44.1)	159 (38.1)	49 (14.2)	25 (4.0)
Did distance learning affect your understanding of the course/topics?	265 (63.5)	107 (25.7)	30 (7.2)	15 (3.6)
Did distance learning affect your training as described in the curriculum?	45 (10.8)	358 (85.9)	7 (1.7)	7 (1.7)
Do you worry about being a medical sciences student (i.e radiographer)?	112 (26.9)	208 (49.9)	70 (16.8)	27 (57.4)
Has distance learning affected your assessments?	144 (54.5)	235 (56.4)	22 (5.3)	16 (3.8)

Table 3. Participants responded to questions regarding online experience (learning & assessment) during COVID-19 (n [%])

Items for quantifying online experience	Very good	Good	Neutral	Bad	Very bad
Possibility to connect to the Internet.	44 (10.6)	141 (33.8)	88 (21.1)	102 (24.5)	4 (9.8)
Availability of digital equipment (phone/tablet/laptop computer).	93 (22.3)	168 (40.3)	67 (16.1)	51 (12.2)	38 (9.1)
Availability and utility/efficiency of the online platforms.	26 (6.2)	137 (32.9)	94 (22.5)	83 (19.9)	77 (18.5)
Interaction and communication with teachers (teaching courses, conducting laboratories/seminars/other practical applications).	27 (6.5)	150 (36.0)	109 (26.1)	69 (16.5)	62 (14.9)
Quality of online learning content (e.g., courses, multimedia content, audio, audio-video, etc.).	17 (4.1)	171 (41.0)	113 (27.1)	60 (14.4)	56 (13.4)
Motivation to learn.	36 (8.6)	106 (25.4)	74 (17.7)	62 (14.9)	139 (33.3)
Assessment/examinations.	17 (4.1)	105 (25.2)	92 (22.1)	81 (19.4)	122 (29.3)

**Figure 1.** Students' responses regarding option to combine traditional (face-to-face) education with online education (Source: Authors' own elaboration)

Most students gave 'good' ratings to the evaluation of online teaching and learning during the COVID-19 pandemic (Table 3). Almost 40% found the quality of online learning content and availability of digital equipment to be good. Students who did not provide these scores, however, should receive extra attention since they may fall into a vulnerable category that requires the development of successful support strategies.

Students reported that in general the motivation for online learning and for examinations was very low. 33.0% of the students found that the combination between online and on-site learning was good (Figure 1).

In response to a question about the advantages of combining face-to-face and online learning, they listed face-to-face communication and teacher-student interaction" as top

benefit (52.0%), followed by less time in front of screen (51.0%), 49.0% the ability to perform practical applications and 415 face-to-face communication and interaction with colleagues. 39.0% improving mental health and wellbeing (Figure 2).

In response to questions that evaluated student performance, most students (51.1%) reported an inability to focus during remote teaching sessions when compared to face-to-face teaching. The results demonstrated a neutral response regarding improvements in their performance. 30.5% reported difficulties in adapting to new teaching techniques, and 31.9% did not feel they had the skills required to embrace new teaching techniques (Table 4).

42.4% of students responded saying they would agree to have the COVID-19 vaccine. Moreover, most of them (35.0%) believe that frontline medical science students should undergo mandatory vaccination. However, they disagreed about the availability of sufficient information about the benefits and risks of the currently available vaccines. 60.0% of the students agreed that vaccinations will change the way in which we practice infection control 48.7% of students believe that the vaccine will improve their access to training (Table 5). Regarding the development of educational resources (Table 6), students strongly agreed that new material to teach how to image and diagnose COVID-19 is required (43.6%). They strongly agreed that precautionary instructions during working with COVID-19 patients should be given to the medical science students during their studies (43.3%).

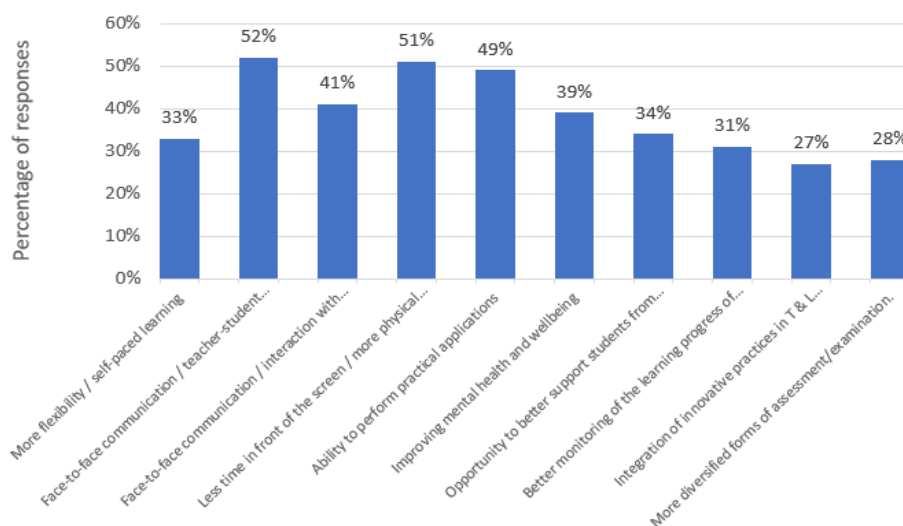
**Figure 2.** Students' response regarding question two (section three)-what the advantages of would be combining face-to-face education with online education? (Source: Authors' own elaboration)

Table 4. Participant responses to questions about their performance during on site classes that were cancelled (n [%])

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
It is more difficult for me to focus during online teaching in comparison to on-site teaching.	98 (23.5)	213 (51.1)	50 (12.0)	36 (8.6)	20 (4.8)
My performance as a student has improved since on-site classes were cancelled.	19 (4.6)	19 (4.6)	144 (34.5)	110 (26.4)	125 (30.0)
I have adapted well to new teaching & learning experience.	94 (22.5)	27 (6.5)	102 (24.5)	127 (30.5)	67 (16.1)
I can master the skills taught in class this year even when on-site classes were cancelled.	52 (12.5)	21 (5.0)	116 (27.8)	133 (31.9)	95 (22.8)

Table 5. Participants responses to statements about the COVID-19 vaccine (n [%])

Statement	Strongly agree	Agree	Disagree	Strongly disagree
I would have the vaccine, if /when it becomes available.	177 (42.4)	164 (39.3)	55 (13.2)	21 (5.0)
Frontline medical sciences students (i.e., radiographers) should be given priority when the vaccine becomes available.	154 (37.0)	214 (51.3)	41 (9.8)	8 (1.9)
Working practices will change. The vaccine should be available when working with COVID-19 positive patients.	214 (51.3)	130 (31.2)	60 (14.4)	13 (3.1)
Vaccination of medical sciences students should be mandatory.	126 (30.2)	146 (35.0)	101 (24.2)	44 (10.6)
There is sufficient information about benefits & risks of COVID-19 vaccines.	119 (28.5)	37 (8.9)	182 (43.6)	79 (18.9)
Vaccinations will change the way in which we practice infection control, i.e., use of personal protective equipment's (PPE).	220 (52.8)	60 (14.4)	111 (26.6)	26 (6.2)
Vaccination will improve access to practical/clinical training.	203 (48.7)	115 (27.6)	77 (18.5)	22 (5.3)

Table 6. Participants responses to questions regarding requirements for information on pandemic in terms of radiological knowledge (n [%])

Question	Strongly agree	Agree	Disagree	Strongly disagree
Is it important to add new information (chest CT, PCR testing) to teach medical science students how to image and diagnose COVID-19?	182 (43.6)	176 (42.2)	44 (10.6)	15 (3.6)
Precautionary instructions when working with the COVID-19 patients should be given to the medical science students during their studies.	181 (43.3)	210 (50.4)	19 (4.6)	7 (1.7)

DISCUSSION

Most academic institutions switched to using online learning as an alternative during the early phases of the COVID-19 pandemic to ensure the safety of staff and students [11]. Additionally, several medical schools implemented open-book exams as they transitioned to a brand-new, totally online method of teaching and assessment [12].

Studying the effects of online learning for radiography students was crucial since there was a significant shift to online learning. It is well known that clinical basic science courses are more adaptable to being converted to online learning because they require less real-time interaction between the lecturer and the students. Clinical practice courses, on the other hand, require on-site interactions for the purpose of clinical practice and developing clinical skills.

With the help of 417 respondents from Jordan, an overview of student radiographers' experiences during the COVID-19 pandemic was obtained. Radiographers are front-line medical staff who were essential to the delivery of healthcare during the early phases of the COVID-19 pandemic [13-15]. Maintaining sufficient workforce numbers, especially as health services recover from the first effects of COVID-19 and become ready for additional pandemic waves, depends heavily on the entry of fresh graduates into the profession [16-18]. Due to the impact of COVID-19 on medical imaging services during the first half of 2020, radiography training was impacted in many countries. To best inform ongoing planning as we move through the pandemic, radiography education institutions and clinical partners need to be aware of student radiographer issues [19]. A review of the research on the impact of COVID-19 on radiography students reveals that only a few studies have

investigated this specific population. The impact of the pandemic among radiography students in Jordan has not been studied yet. Moreover, previous research focused on students' mental status without investigating the impact on their teaching and learning. Furthermore, no previous research has been conducted that considers the effect of the availability of vaccines on student opinions, training, and learning.

Our study discovered various difficulties that need to be considered, starting with the availability of the necessary facilities for online training. In our study, the majority of students reported that they were without the necessary infrastructure (e.g., digital equipment, the Internet connection). It is important to note that Jordanian telecommunications firms experienced losses due to a heavy load on the internet network, which affected connections and internet speeds in various locations [20].

Moreover, some areas in Jordan suffered lifestyle issues, such as the family's inability to support university study, buy equipment, or even provide access to the internet. The opinions of the majority of students were generally positive regarding interaction and communication with teachers and the quality of online learning content. However, 33.3% of students reported a lack of motivation to learn online, and 29.0% were not satisfied with their assessments and evaluations during this period. This latter point could be a result of educators trying to make the experiences fairer and to prevent misconduct. When asked questions about the relationship between COVID-19 and educational activity, 44.0% agreed that there is a relationship between COVID-19 and changes to educational activity. Almost 64% of the students found that distant learning affected their understanding of the course, and 86.0% strongly agreed that their training was affected during this period. The COVID-19 pandemic has made

it difficult to implement clinical training for future health professionals worldwide [19].

It is worth mentioning that students were not on clinical placement during the lockdown period in Jordan. This is very important since most radiography schools depend on practical education and students acquire clinical competencies in hospitals. This is one of the biggest disadvantages for radiography students when faced with reduced access to clinical settings. To ensure the quality of education, additional steps should be considered, such as the greater inclusion of simulation. Despite the aforementioned difficulties, 70 (16.7%) of the respondents said they were not at all concerned about becoming a radiographer. Education organizations should be aware that the remaining half (49.8%) of respondents were worried. These results are in line with the report by Rainford and colleagues [10].

The possibility of combining traditional education with online education for the academic year 2020-2021 was the third topic covered in the survey. Most students (33.0%) agreed with this option when asked how they feel about it in light of their learning needs, while 19.0% expressed a neutral opinion and 26.0% said it was “bad” or “very bad”. In response to a question about the advantages of combining the two forms of education, they put “face-to-face communication and teacher interaction” first, “less time in front of a screen” second, and “more physical activities” third. In third place, 49.0% reported their ability to “perform practical applications”.

Most previous research addresses the effect of the pandemic on students’ psychological well-being and levels of anxiety [21-23]. The effect of COVID-19 on students’ performance is important. One of the aims of this study was to evaluate the effect of the pandemic on their performance. 51.0% responded, stating it is more difficult to focus during online teaching when compared to on-site teaching. Most students (34.5%) had a neutral opinion about the improvement of their performance during this period. 30.5% of students stated that they had not adapted well to the new teaching and learning activities. Moreover, 31.9% reported that they could not master the skills taught in class this year, even when on-site classes were cancelled. This is due to the possibility that, prior to the pandemic, traditional face-to-face teaching did not include virtual learning systems [23]. The lack of prior experience, visual aesthetics, and user interface characteristics may have all played a role in the students’ dissatisfaction with the online system [24-26].

Importantly, this research highlights an important point, which is students’ information about the vaccines and their opinion regarding the effect of this on their education. This is a very important point, as at the beginning of the pandemic there were fears about taking the vaccine because of a lack of sufficient information. This subject was a novel feature of our survey. Despite challenges regarding the vaccines, 42.4% of respondents agreed to have them when they became available. Respondents also strongly agreed that medical science students should have the vaccine, and 35.0% reported that it should be mandatory. However, 43.6% of them believe that there is not sufficient information about the benefits and risks of the COVID-19 vaccine. 52.8% think that vaccination will change the way in which we practice infection control, i.e., the use of personal protective equipment (PPE). 48.7% suggested that they believed access to vaccination would improve practical ‘clinical’ training.

The last section of this research deals with the radiological knowledge required relating to COVID-19. This is another important point, as educators need to develop training curricula in light of COVID-19. 43.6% of the students agreed that it is important to add new material (chest CT, PCR testing) for medical science students in relation to COVID-19. In addition, most of the students (50.4%) strongly agreed that the precautions needed when working with COVID-19-positive patients should be taught to medical science students during their training.

Limitations

Several limitations to this study exist, generalizability of the results is limited in that the questions were restricted to radiography students in Jordan. The types of virtual learning platforms, how students are assessed, and how they affect respondents’ experiences in learning and teaching were not specifically evaluated in the study. Due to issues with internet accessibility or connection issues, some students could not access the survey. As one of the difficulties with online learning, the survey’s requirement for internet connectivity could have been a barrier for responders. It’s possible that the study’s quantitative design prevented respondents from providing detail free-text responses on the topic.

CONCLUSIONS

Undoubtedly, COVID-19 has had an effect on radiography education in Jordan, as it has in other nations. Although it appears that online learning platforms have mostly supplanted in-person instruction, students are not acclimated to their use. clinical rotations, a vital component of health training programs, have been significantly impacted by the pandemic. To enhance student achievement, clinical radiography training institutions must modify their educational approaches. Adopting mixed learning methodologies and using simulation to improve the likelihood of practical placement are two new instructional tactics that will improve learning. Educators and international society should also work to create the required infrastructure to properly integrate online training based on global experiences.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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