

RESEARCH REPORT

Remote learning during Covid-19 lockdown: A study on anatomy and histology education for pharmacy students in Jordan

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Abstract

The Covid-19 pandemic has changed almost all aspects of education. The anatomy and histology courses for pharmacy students focus heavily on the face-to-face communication of theory and practical knowledge, and due to the pandemic, only theory content was delivered in an online format. This brought up many concerns about pharmacy student preparedness. This work explores the effectiveness and student perspective of remote teaching of the theoretical anatomy and histology course in Jordanian universities from the perspective of pharmacy students. The objectives are to determine the strengths, challenges, and the effectiveness of remote delivery on student learning. An online-based validated questionnaire was distributed to students majoring in Pharmacy and enrolled in the course during the second semester of 2019–2020 at 11 universities in Jordan. A total of 442 students participated in the study. Results showed that there were significant differences in perceptions of the social media platforms used in distance learning and remote delivery of the course. Most participants had positive perceptions of the educational process and studying via distance learning. There were many strengths noted including time flexibility and several challenges such as the lack of face-to-face interaction with instructors, inadequate internet connectivity, and technical issues. In conclusion, online-taught anatomy and histology course during the Covid-19 lockdown in Jordan was a success as perceived by students, but the course still possessed challenges need to be overcome in the future.

KEYWORDS

Covid-19, Covid-19 lockdown, gross anatomy education, histology education, Jordan, pharmacy education

INTRODUCTION

Health professionals, including pharmacists, must be able to connect human organs and systems' structure to their function. Therefore, the theoretical concepts of anatomy and histology are one of the cornerstones in healthcare professional curricula, and understanding these concepts is fundamental for safe practice. Thus, a foundation of anatomy and histology knowledge is crucial for pharmacy graduates upon which they can build their pharmacological knowledge

(Finn et al., 2018). Pharmacist training programs in Jordan require anatomy and histology courses and dictate that they should be studied within the first two years (Al-Wazaify et al., 2006).

The Higher Education Accreditation Commission (HEAC) in Jordan approves and regulates higher education programs, including pharmacy, and it oversees program accreditation guidelines and standards for the medical and health sciences majors. Bachelor of pharmacy program must include a minimum of 160 credit hours per the HEAC (previously 150 credit hours), where a credit hour is

equivalent to one hour per week in a sixteen-week semester. These 160 credit hours are distributed across theoretical and practical fields of knowledge, namely, (1) Chemistry (pharmaceutical and medical) including physical pharmacy, organic chemistry, analytical chemistry, medicinal chemistry, instrumental analysis, biochemistry, clinical biochemistry, chemistry of natural products, and drug design, (2) Pharmaceutics (pharmaceutical and medical) including pharmaceuticals, industrial pharmacy, cosmetics, biopharmaceutics, pharmacokinetics, and pharmaco-economics, (3) Medical sciences including anatomy and histology, physiology, pharmacology, pathophysiology, applied and pharmaceutical microbiology, toxicology, immunology, and clinical pharmacy, and (4) Advanced pharmaceutics including pharmaceutical technology, pharmaceutical biotechnology, pharmaceutical marketing, and phytotherapy. These fields supported by more general courses including chemistry, general biology, calculus, physics, and other university requirements (HEAC, 2014; Alabbadi, 2015). Usually, the faculty committee responsible for curriculum development and implementation will determine set the progression of study for five-year pharmacy programs. The students are advised to enroll and complete courses according to the flow of the study plan. This ensures a smooth transition between courses and that both pre- and co-requisites requirements are satisfied.

In most pharmacy program curricula, the theoretical course of anatomy and histology is a two to three credit-hour course. Students are introduced to the four types of tissues structurally and functionally, the organization of the human body, and the anatomical terminology such as planes, views, and positions. The students then learn the anatomy and histology of the human body system namely, skeletal, muscular, nervous, cardiovascular, lymphatic, digestive, respiratory, integumentary, endocrine, and urogenital systems, and special senses. The learning outcomes of such a course are tested primarily by recalling facts and basic concepts which include but are not limited to listing, describing, defining, and identifying cells, tissues, organs, parts of organs, and systems. In some curricula, theoretical courses are taught parallel to practical courses, during which students spend two or three actual hours equivalent to one credit hour in laboratory to study prepared histological slides, preserved organs, and plastic models related to the organs and systems of the human body.

In Jordan, most educators rely on theoretical explanation and presentation using figures or plastic models to illustrate the anatomical structures rather than cadaveric dissection (Al-Wazaify et al., 2006; Mustafa et al., 2013). The face-to-face methods of teaching include but are not limited to lectures, in-class discussions, and sometimes lectures recorded on e-learning websites, along with online discussion, assignments, and take-home examinations that are all uploaded to e-learning websites. Students are assessed through midterm and final examinations, quizzes, and assignments which include term papers, summarizing chapters, preparing and giving a short lecture. Before the Covid-19 lockdowns, blended learning was initiated in Jordan, and online educational platforms were already being used (Almarabeh, 2014). However, online platforms were only used to distribute recorded lectures, question banks, supplementary material, and online examinations (Al-Wazaify et al., 2006).

The worldwide outbreak of Covid-19 led to government interventions such as lockdowns and closure of many institutions including universities (Brassett et al., 2020). This unexpected situation brought about a sudden interruption in student learning, resulting in the need to rapidly transition to exclusively online education and student assessment. These challenges were experienced internationally and notably documented in the United Kingdom and Republic of Ireland (Longhurst et al., 2020), Australia and New Zealand (Pather et al., 2020), China (Cheng et al., 2021), Malta (Cuschieri & Calleja Agius, 2020), Malaysia and Indonesia (Efendie et al., 2020), India (Singal et al., 2020), Saudi Arabia (Almetwazi et al., 2020; Memon et al., 2021), Czech (Eberlová & Mansfeld, 2020), Korea (Yoo et al., 2021), and others.

The government of Jordan followed the example of many other countries in taking protective measures to inhibit the spread of the Covid-19 virus. Consequently, the Ministry of Higher Education and Scientific Research made an unprecedented switch from conventional on campus in-class face-to-face education to online education.

Internationally, anatomy courses in particular were interrupted during Covid-19. The effectiveness of online anatomy education has been dependent on reliable internet access for students and instructors, accessibility of online resources, appropriate institutional infrastructure, and the acceptance and preparedness of both instructors and students for online delivery (Qazi et al., 2020; Shawaqfeh et al., 2020). In this context, student mental health and motivation for virtual education is a previously acknowledged challenge that could impact educational effectiveness (Bao, 2020; Srivastava et al., 2021). Previously, the establishment of a fully online postgraduate program in anatomical sciences was successful (Olt, 2002; Robles & Braathen, 2002; Admiraal et al., 2015), but the absence of access to physical anatomical materials (Gillingwater, 2008; Kelsey et al., 2020) was noted as an obstacle. Indeed, students reported that the flexible nature of online study enabled them to work at a time, location, and speed that suited them best regardless of geographical location (Kelsey et al., 2020). Also, students perform better on examinations after blending learning and computer-assisted teaching when compared to traditional teaching (Elizondo-Omaña et al., 2004; Pereira et al., 2007). Blended courses consist of a diverse mix of text-based information, informative video lectures, and online quizzes (Kelsey et al., 2020).

Nonetheless, literature lacks studies on the efficacy of exclusively online basic sciences courses for pharmacy students in Jordan and the broader Middle East region. The delivery of anatomy and histology online is particularly interesting given the rise in personal smart devices and technology. Accordingly, anatomy instructors in Jordan should expend great effort in promoting their students' learning online.

Hypothesis and aims

The study hypothesized that the remote delivery of an anatomy and histology course during Covid-19 would negatively impact the

content, teaching style, student achievement, and student satisfaction. This research report aimed to explore the effectiveness of remote teaching in theoretical anatomy and histology to pharmacy students in Jordanian universities during the Covid-19 lockdown. The objectives were to determine (1) the aspects of the remotely delivered course, (2) the strengths and challenges of remote delivery, and (3) the effect of online delivery on students' learning.

MATERIALS AND METHODS

This is a cross-sectional study that was undertaken using an online questionnaire conducted in June 2020 with voluntary participation from students studying pharmacy in Jordanian universities. The study was approved by the Ethical Review Committee of the Faculty of Allied Medical Sciences at the Al-Ahliyya Amman University (approval number 1/5/2019–2020). Relative to its geographical size, Jordan has a high number of pharmacy professional programs (Alefan & Alsmadi, 2017). In Jordan there are 25 universities, 18 of which offer a bachelor level qualification in pharmacy or in pharmaceutical sciences. During the second semester 2019–2020 (February 2020–June 2020), only 14 Schools of Pharmacy offered the theoretical anatomy and histology course with a total of 1,500 pharmacy students enrolled (the number of students was calculated by the first author (Z. M. A.) after contacting anatomy and histology instructors and/or anatomy students at each school). Data for this study was collected from students in 11 of the 14 Schools of Pharmacy.

Inclusion and exclusion criteria

This study included pharmacy students from 11 of the 14 Schools of Pharmacy in Jordan, who were studying theoretical anatomy and histology during the second semester of 2019–2020. The exclusion criteria were (1) students who were not majoring in pharmacy, (2) students who were not studying theoretical anatomy and histology during the second semester 2019–2020, and (3) students studying in a non-Jordanian university.

Questionnaire validation, pilot testing, and study

On March 26, 2020, a group of students from Al-Ahliyya Amman University, Amman, Jordan were asked to write down the strengths and challenges of e-learning during the pandemic, and their feedback was taken into consideration while drafting the questionnaire. Some of their comments on the strengths were: *“Easier to get to the lecture on time.”*, *“I have more time to study and finish assignments now.”*, *“It's great to study from home, and I have time to write all the notes I need which helps me keep up with the curriculum.”*, *“The positive points to me are that we can review our lecture more than once and at any time, we are always prepared by watching the recorded lectures*

before the live streamed ones, and then we can ask our teacher any questions about any point we didn't understand. And I think studying our lectures online helps us become more responsible students especially at this period of time.”

The challenges were also indicated: *“For me, I don't face so many problems while studying the Anatomy course online, just several technical issues sometimes like a system problem while taking a quiz or doing an assignment, or some of the students can't join the meeting until someone invites them to join.”* *“Not being in class and interacting with the lecturer in person.”* and *“The internet connection isn't good.”* This point was repeated by several students.

Most of anatomy and histology instructors from the 11 of the 14 Schools of Pharmacy in Jordan, who were teaching theoretical anatomy and histology during the second semester of 2019–2020, were contacted by the first author (Z. M. A.) and were asked about strategies used for course delivery. The questionnaire was designed and drafted in Arabic, the mother language in Jordan and the region. Afterwards, it was reviewed by four independent scientists for validation: a professor of clinical pharmacy, a professor of embryology and histology, a professor of pathology who has taught anatomy and histology courses for several years, and a professor of educational sciences. All their comments and remarks were taken into consideration. The comments focused on language and the spelling, deleting redundancies, and relocating questions into a logical order. After drafting the questionnaire and feedback-based revision, the survey was created using “Google Forms” online survey platform (Google LLC., Mountain View, CA). It was then distributed to students directly if they attended the authors' home institutions or through a third-party instructor and/or a lead student who could distribute the questionnaire via Jordanian student social media groups. The questionnaire was available online during June 2020.

Students gave their consent by answering the first question in the survey which was “Would you like to participate voluntarily in the study?”. Students who did not agree did not give responses to the questionnaire. Moreover, it was clearly stated in the introduction of the questionnaire that there are no questions regarding about personal information and that data will be confidentially and professionally handled according to scientific research standards and ethics. Students were also informed that they could withdraw their answers anytime during the study without having to give reasons.

The questionnaire consisted of 45 questions in five sections. The first section included ten demographic-related questions which asked participants to report their grade point average (GPA), gender, type of high school certificate, university name, and educational and social media platforms used during lockdown. The following sections consisted of five-point Likert scales targeting educational process components (11 questions), strengths (8 questions) and challenges (9 questions), and the effect of remote learning on student study habits (7 questions). The five-point Likert scale corresponded to 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

Later the questionnaire was translated to English by the author (S. W. A.) for publication and is available as the supplemental

material file. Respondents who answered strongly agree or agree were classified as positive perceptions of the educational process components except for in questions number four and eight where positive perceptions were considered strongly disagree or disagree.

The respondents to the questions on strengths and challenges were put into two groups. The respondents who answered either strongly agree or agree were considered to have strengths/challenges while those who answered either neutral, disagree, or strongly disagree were considered to have no strengths or challenges during distance learning and the remote delivery of the anatomy course.

In the student perceptions section, those who answered either strongly agree or agree were considered to have positive perceptions of distance learning in the anatomy course.

The questionnaire was deemed reliable based on the Cronbach alpha coefficient (0.858) and its 95% CI (0.837–0.877).

Statistical analysis

Descriptive statistics were used to describe students' demographic characteristics. Continuous data were reported as median (interquartile range [IQR]) for non-normally distributed variables, providing that the IQR describes the middle 50% of values when ordered from lowest to highest. To determine the relationship between perception scores and the independent categorical variables, the Mann-Whitney *U* test was utilized for binomial variables while the Kruskal-Wallis test was used for multinomial variables. A two-sided $p < 0.05$ was considered as statistically significant. The statistical analyses were carried out using the Statistical Package for the Social Sciences, version 22, (SPSS Inc, Chicago, IL).

RESULTS

Demographic data

A total of 442 students participated in the study, and of those, 40 were excluded from the analysis: 10 declined to take part, 15 reported studying a specialty other than pharmacy, 12 did not study the anatomy course, and 3 were from universities that do not have pharmacy among their programs. Thus, in the present analysis, 402 responses were analyzed, and of those, 65.7% ($n = 264$) were female and 34.3% ($n = 138$) were male. GPAs were rated as very good (40.8% of participants and $n = 164$) if they were scoring 76%–85% or reached 3.00–3.69 points out of a 4 point GPA (the range slightly differs according to the university grading systems). About two-thirds of students had a Jordanian national high school certificate ($n = 252$, 62.7%). The largest proportion of participating students live with their families ($n = 295$, 73.4%). General demographic data of the participating students are presented in Table 1.

About half of respondents reported that none of the social media platforms were used in the distance learning process ($n = 187$, 46.5%). In contrast, 70.9% ($n = 285$) of students reported using Microsoft

TABLE 1 Characteristics of included study participants

Characteristics	Number of responses <i>N</i> (%)
Total number of students	
Surveyed students	442(100.0)
Included in the study	402 (91.0)
Excluded from the study	40 (9.0)
Sex	
Male	138 (34.3)
Female	264 (65.7)
Self-reported grade point average (GPA)	
Poor	5 (1.2)
Fair	13 (3.2)
Good	79 (19.7)
Very good	164 (40.8)
Excellent	141 (35.1)
Type of high school education	
Jordanian national high school	252 (62.7)
National high school from other sister Arab countries ^a	133 (33.1)
International high school certificates: Scholastic Assessment Test (SAT), International General Certificate of Secondary Education (IGCSE) or Advanced level of General Certificate of Education (A-level/GCSE) ^b	16 (4.0)
Other	1 (0.3)
Place of living	
Live with my family	295 (73.4)
Live with my relatives	11 (2.7)
Live in a student dormitory	28 (7.0)
Live in an apartment with roommates	27 (6.7)
Live in an apartment on my own	41 (10.2)
University attended	
Al-Ahliyya Amman University	125 (31.1)
Al-Zaytoonah University of Jordan	100 (24.9)
Applied Science Private University	36 (9.0)
Philadelphia University	34 (8.5)
Mutah University	32 (8.0)
Zarqa Private University	23 (5.7)
Al-Isra University	14 (3.5)
Jadara University	14 (3.5)
Middle East University	11 (2.7)
Amman Arab University	7 (1.7)
American University of Madaba	3 (0.7)
Did not answer ^c	3 (0.7)

Note: Number of study participants in each category ($n = 402$).

^aStudents from many sisters' Arab countries study in the Jordanian universities, such as some countries from Gulf Cooperation Council, Middle East/North Africa (MENA) and others.

^bInternational high school certificates, offered by some private schools in Jordan, students choose to study this/these programs instead of the Jordanian national high school certificate.

^cThis question was not obligatory.

Teams (Microsoft Corp., Redmond, WA) in the distance education process. Most students ($n = 283$, 70.4%) used a mobile (cell phone) as a digital device during the distance learning process. Interactive delivery of the lectures via livestream at the original lecture time was reported by 32.1% ($n = 129$) of students. Characteristics of distance learning tools and communication are presented in Table 2.

Aspects of the course delivered remotely

When students were asked if social media platforms were used in the distance education process, the overall median perception score was 3.82, IQR = 0.82 in the whole study sample. There was

no difference in the perception score across gender and other demographic characteristics. Nevertheless, there were significant differences in perceptions of the social media platform used in distance learning, i.e., the use of WhatsApp (WhatsApp Inc., Mountain View, CA) was highly associated with a lower perception score ($p = 0.03$). The perceptions of students are shown in Figure 1 and Table S1.

Most participants had positive perceptions toward the educational process via distance learning except when rating practice aspects where only 10.7% ($n = 43$) disagreed that the remotely taught courses were purely descriptive (theoretical) focusing on theory rather than on practice. Results of the median perception scores are portrayed in Table S2.

TABLE 2 Characteristics of distance learning tool and communication

Characteristic	Number of responses N (%)
Social media platforms used in the distance education process ^a	
Facebook (Facebook, Palo Alto, CA)	133 (33.1)
WhatsApp (WhatsApp Inc., Mountain View, CA)	65 (16.2)
YouTube (YouTube, LLC., San Bruno, CA)	51 (12.7)
Not used	187 (46.5)
Educational platform/s used in the distance education process ^a	
Microsoft Teams (Microsoft Corp., Redmond, WA)	285 (70.9)
Moodle (Moodle Pty Ltd., West Perth, WA, Australia)	101 (25.1)
Google classroom or Google Hangout (Google LLC., Mountain View, CA)	8 (2.0)
Zoom (Zoom Voice Communications Inc., San Jose, CA)	95 (23.6)
Other	3 (0.7)
Digital device ^a	
Laptop	194 (48.3)
Tablet or iPad (Apple Inc., Cupertino, CA)	31 (7.7)
Mobile (cell phone)	283 (70.4)
Type of internet you used	
Asymmetric digital subscriber line (ADSL) ^b	59 (14.7)
Fiber-optic communication	107 (26.6)
The fourth generation of broadband cellular network technology (4G)	170 (42.3)
Do not know	66 (16.4)
The communication status with the course instructor	
The instructor always replies to my messages	332 (82.6)
The instructor sometimes replies to my messages	40 (10.0)
The instructor hasn't replied to any of my messages	4 (1.0)
I did not try to communicate with the instructor at all	26 (6.5)
Way of provision of the course content ^a	
In an interactive livestreaming way with students in your section at the original lecture time	129 (32.1)
In an interactive livestreaming way with students at a different time of the original lecture, with all sections merged	35 (8.7)
In an interactive livestreaming way with students at a different time of the original lecture time, only for students in your section	26 (6.5)
Through previously recorded lectures before the lockdown period (blended education)	122 (30.3)
Through recorded lectures during the lockdown period	121 (30.1)

^aMore than one option was allowed for answer.

^bAsymmetric digital subscriber line (ADSL) is a data communications technology that uses telephone lines for data transmission.

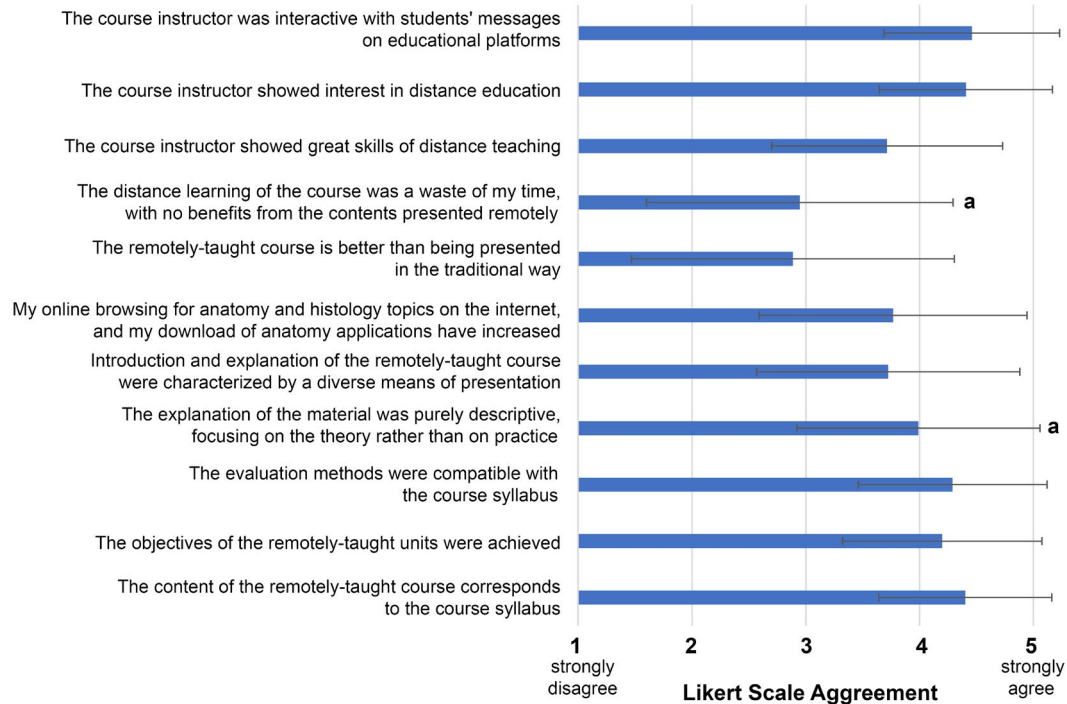


FIGURE 1 Responses of participants regarding remotely delivery theoretical anatomy and histology ($n = 402$). The responses are graphed as means (\pm SD) on a Likert scale where 1 = strongly disagree and 5 = strongly agree. ^aFor negatively worded questions scores were reversed

Strengths and challenges of distance learning

The overall median strengths and challenges scores were 4.06, IQR = 1.125 and 3.44, IQR = 1.12, respectively, in the whole study sample. There was no difference in the strengths score based on gender and other demographic data nor with the characteristics

of distance learning tools and communication. Nevertheless, there were significant differences in the challenges score and the use of WhatsApp as a distance learning platform, i.e., the use of WhatsApp in distance learning was highly associated with a lower challenge score ($p = 0.001$). Students' responses to the strengths and challenges of distance learning are shown in Figures 2 and 3 and Table S1.

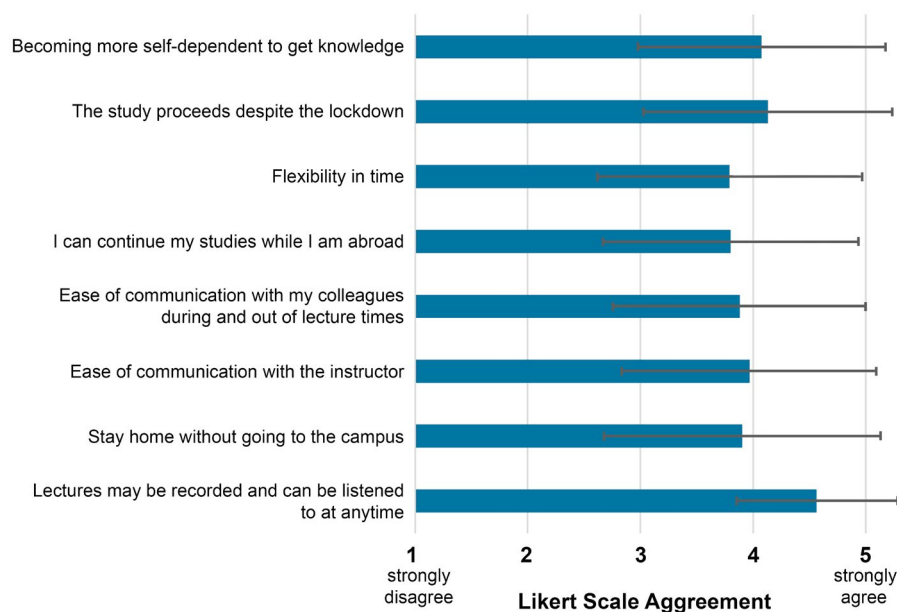


FIGURE 2 Students' responses to questions related to the strengths of distance learning ($n = 402$). The responses are graphed as means (\pm SD) on a Likert scale where 1 = strongly disagree and 5 = strongly agree

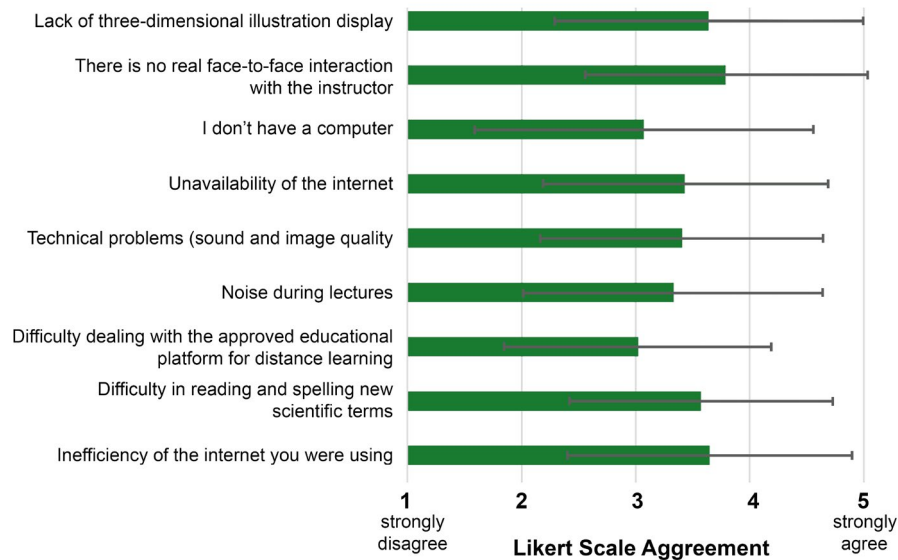


FIGURE 3 Students' responses to questions on the challenges of distance learning ($n = 402$). The responses are graphed as means (\pm SD) on a Likert scale where 1 = strongly disagree and 5 = strongly agree

Effect of remote delivery on students learning

The responses on student perceptions of how online anatomy and histology can change their study methods are shown in Figure 4 and Table S1. In general, their perceptions were positive (perception score ≥ 3) as shown in Table S3. The overall median perception score was 3.57, IQR = 1.14. Higher perception scores were observed with those who used YouTube (YouTube, LLC., San Bruno, CA) in the distance learning process ($p = 0.001$). Only 40.8% of students positively perceived that the remotely taught course contributed to a better understanding of the course content compared to the pre-lockdown course.

DISCUSSION

The Covid-19 pandemic has affected education worldwide, accelerating a great need for adaptations to diverse changes in education (Longhurst et al., 2020). In this study, a questionnaire was developed and analyzed to examine remotely delivered anatomy and histology, the strengths and challenges of remote delivery, and its effect on students' learning. The study is representative of pharmacy students in Jordan, who remotely studied theoretical anatomy and histology courses during the second semester 2019–2020 (February 2020–June 2020). This study was conducted because students' experiences, perceptions, and feedback are critical for innovation and

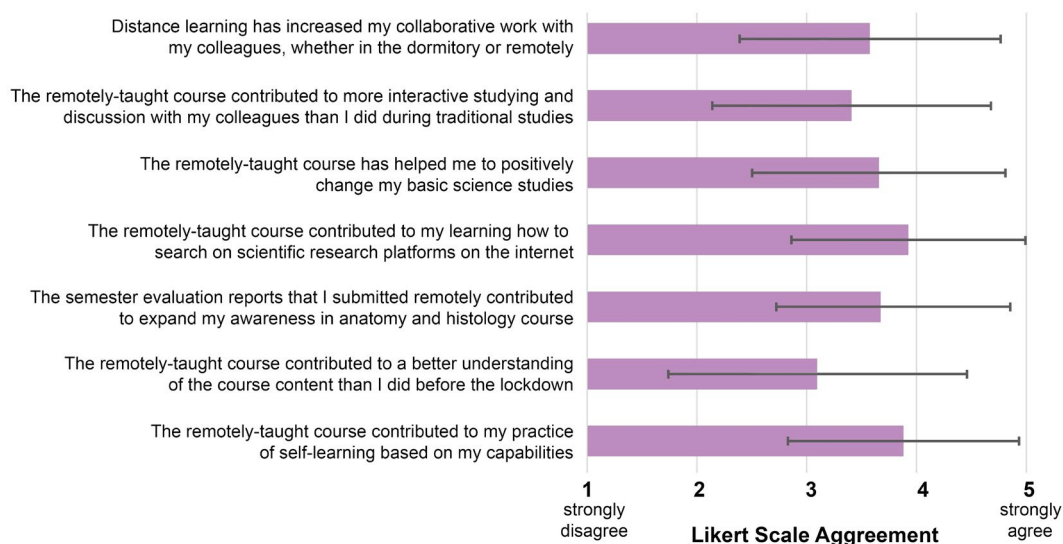


FIGURE 4 Responses of the students regarding the effect of remote delivery of theoretical anatomy and histology on their learning ($n = 402$). The responses are graphed as means (\pm SD) on a Likert scale where 1 = strongly disagree and 5 = strongly agree

improvement in the curriculum, and efficient and safe program delivery. Particularly, on-line courses and/or sessions will be an important part of any curriculum in the future until the pandemic is under control. Even then, universities should blend both face-to-face and online teaching. Indeed, in January 2021, the Ministry of Higher Education and Scientific Research in Jordan acknowledged and approved an executive action plan for e-learning integration in 2021–2023 that supports blended education. This directive was circulated to the universities for implementation and resulted in follow-up committees to track progress in this area (MOHE, 2021).

In this study, students' perceptions of the educational process of the anatomy and histology courses delivered remotely were favorable, correlating with other countries' surveys; for instance, students in Korea expressed a preference toward online lectures over conventional in-class teaching (Yoo et al., 2021). Overall, there was positive feedback on the course content as content was seemed as consistent with the syllabus and the objectives by 90.1% and 82.1% of student respondents respectively. More than half of anatomy teachers that participated in a study in China stated that online teaching during the pandemic was satisfying and effective (Cheng et al., 2021). This might explain why in this study, instructors were praised as being interactive with student messages and inquiries on educational platforms (90.1%). Indeed, educators have worked continually to provide a smooth transition to exclusively distant learning. Further, 87.6% of students found that their instructor showed an interest in distance education, and 55.2% of students found that the educators had great skills in online teaching. In this regard, the adaptability of the anatomy instructors enabled the efficient continuity of anatomy education programs during the Covid-19 pandemic, which is in line with the findings by Pather et al. (2020). Despite many challenges and speed of the transition to lockdown and online life, the majority of students (84.6%) found that the assessment methods used in the course were compatible with the syllabus. This is consistent with students in Saudi Arabia who were also satisfied by the assessment quizzes that were conducted (Memon et al., 2021).

Just like the students in Korea, who increased their self-study time, individual learning methods, and reviewing of lecture videos (Yoo et al., 2021), the students participating in this study remarked that the remotely taught course contributed positively to their navigation scientific research platforms on the internet (72.9%) and changed their approach to studying basic sciences (57.7%). Almost half of the students (50.5%) reported that the online anatomy courses were more interactive, stimulating greater discussions with their peers than traditional studies, thus increasing collaboration with their colleagues (55.7%). This is because, previously the course rarely included active learning techniques, where students had to work with peer groups or teams. This was also in accordance with what was mentioned in previous studies, where online teaching helped build study groups with students or peers (Alkoudmani & Elkalmi, 2015). Importantly, learning from peers is generally considered critical to the student learning process (Wut & Xu, 2021). Yet, this contradicts Srivastava et al. (2021) findings which reported that 50.5% of their students were not as interactive online as they were

during face-to-face discussion. This could be due to differences in pre- or post-pandemic course format.

In contrast to previously published studies substantiating the widespread usage of YouTube (YouTube, LLC., San Bruno, CA) as a video platform and learning tool (Mustafa et al., 2020), data from this study showed that only a small percentage of students used YouTube, WhatsApp (WhatsApp Inc., Mountain View, CA), and/or Facebook (Facebook, Palo Alto, CA) social media platforms as a supportive method for their educational process. In Jordan, most students created WhatsApp groups to facilitate the communication between classmates, especially during the sudden transition period to remote learning. Nevertheless, some students chose not to join these groups. Moreover, while some instructors preferred to join WhatsApp groups with their students, others didn't engage in unofficial social media groups. This study showed that a minority of participants used WhatsApp in online education. This could be explained by the study of Mawarni et al. (2020) that specifically investigated the effectiveness of using WhatsApp during Covid-19 pandemic. The result of their research showed a negative response as it was a bit difficult for students to understand the learning process when using WhatsApp. The effectiveness of e-learning through WhatsApp was also studied by Gon and Rawekar (2017), and in their study, they observed that message flooding, time consumption, and eye strain were some technical disadvantages detected.

This study revealed that Facebook was used preferentially by most users who engaged in social media platforms. This may be due to it being the most popular social networking site and the second most famous site in the world (Siikanen et al., 2018). This is also in accordance with previous publications documenting pharmacy students prefer web-based learning and use Facebook for sharing their educational experiences and knowledge (Al Subeh et al., 2018). In a complementary manner, Facebook was favorable in online education as it provides a sense of connectedness, enhanced interaction, and an informal learning environment for presenting contemporary issues that expose students to relevant real world topics through the introduction of students and professionals of different affiliations (Cain & Policastri, 2011; Duncan & Barczyk, 2016).

This study showed that the majority of the participants studied independent from YouTube resources and did not use it as a platform. This suggests that online livestream lectures were sufficient for students to view course content. However, instructors have previously been advised to use YouTube as an educational tool in teaching anatomy and to record YouTube videos related to anatomy because it supplements and assists in anatomy learning for medical students (Mustafa et al., 2020). Therefore, instructors may consider recording their lectures and their livestreamed videos for publication on internal online university platforms. This requires involve instructors starting, creating, and storing media content that enrolled students can access. If online content is created by anatomy departments and instructors, this could potentially decrease the reliance on YouTube channels. This will protect universities' intellectual property rights and will not add financial burdens to students who may have to pay for restricted YouTube channels. It is worth

mentioning here that interactive livestreaming involved the instructor starting an online session and inviting the students to attend the class. During the live session, the instructor provides the objectives of each unit, delivers the lecture and any anatomy-related activities, engages the students through brainstorming, and allocates time for questions and answers.

With regards to teaching platforms, most students used Microsoft Teams, (70.9%) which is an online application that helps instructors to build teams for their students, hold recordable meetings, make conversations, and share files. Instructors and students can also chat with each other, send messages, and make calls. As a matter of fact, in Jordan, most universities have subscriptions with Microsoft Corporation (Redmond, WA) that provide the staff and the students with Outlook e-mail accounts. When the pandemic started, most universities upgraded their subscriptions to the latest online version (number 16.0.14131.20278) of Microsoft Office 365 to get automated updates for Microsoft Teams, Microsoft Forms, Microsoft OneDrive (Microsoft Corp., Redmond, WA), and other applications. Assessments were also delivered using one of the official teaching platforms used in universities. For example, assignments and/or quizzes were hosted either on Microsoft Teams or Moodle learning management system (Moodle Pty Ltd., West Perth, Western Australia, Australia) and/or Microsoft Forms.

Most students (70.4%) used their mobiles (cell phones) as their device to digitally attend online lessons. The preference for cell phones could contribute to promoting students' practice of self-learning, expanding their awareness in the anatomy and histology course, and contributing to more interactive studying by increasing collaborative work with their colleagues. These results were in harmony with studies that demonstrated that collaborative learning through mobiles (cell phones) improved student learning performance and participation in learning activity (Liu et al., 2008) and in agreement with studies on new mobile applications that prompt students' self-awareness regarding time management (Runyan et al., 2013).

Results in this study showed that about 90% of participants agreed that the remotely taught courses were purely descriptive (theoretical) focusing on theory rather than practice. It was documented that learning anatomy can be enhanced by relying on accurate anatomical plastic models for facilitated illustration of anatomical structures and 3D virtual simulations (Fredieu et al., 2015; Cortese & Frascio, 2021). However, the anatomy and histology courses taught entirely online were unable to introduce such models during the course. Libraries of virtual slides were not available before the Covid-19 pandemic, but some universities in Jordan have multi-head teaching microscopes for many observers or microscopes that are connected to the data-show projectors in the laboratories of anatomy and histology. Unfortunately, these facilities were not available for use by most universities during the sudden transition to online teaching.

This study describes challenges in online learning that are not specific to anatomy and histology. Previous studies have shown that more broadly challenges included difficulty dealing with the approved educational platform, noise during live lectures, and/

or technical problems such as livestream quality and unavailability of the internet (Lange & Costley, 2020). Furthermore, a study conducted by Mawarni et al. (2020) showed that students experienced some obstacles personally including unstable internet networks, limited data connection quota, difficulty focusing on learning, obstacles in discussing with friends, and the lack of media used in learning. In this study, technical problems were a major challenge. This might be related to the fact that most of the participants lived with their families (73.4%). During lockdown, most family members worked online and used the internet which could interrupt internet connection and consume all available band width. Connectivity problems have been proven to be time consuming (Singal et al., 2020). In line with this study, technical challenges resulting from poor internet connections or low bandwidth were also reported by other scholars (Alkhawaja & Abd Halim, 2019), hence, the economic status of the students affected their academic performance and their reactions to remotely delivered courses. A recent study conducted in Jordan demonstrated that students equipped with strong internet connections showed more interest and positive reactions to online learning. Jordan has limited resources, so low-income students are challenged because they are often deprived of basic e-learning tools such as internet connection service and other equipment supporting online learning (Al-Salman & Haider, 2021).

Lastly, the students' perspectives of online education in the anatomy and histology course implies several advantages from flexibility in time to better communication with their instructors (Thwin, 2017; Kelsey et al., 2020). In concordance with other studies, it is obvious that students perceived some benefits of the remotely taught course in this setting including but not restricted to practicing their self-learning, being more self-dependent, and applying self-regulated learning (Roddy et al., 2017; Wong et al., 2019). The results in this study, support the findings of the previously published review article by Salter et al. (2014) where it was found that e-learning is effective for increasing knowledge immediately after the semester ends. Nonetheless, it should be kept in mind that students are not well qualified to assess how they have comprehended the material because self-evaluation errors of high and low achieving students differ (Dunning, 2011). Accordingly, future studies should explore the effects of anatomy and histology e-learning on course and program outcomes upon graduation and measure correlations to the platform for assessments and the student experience and perception of learning. Finally, online teaching has triggered the need to reassess and rework the contents, study plans, and curricula (Evans et al., 2020; Ortadeveci et al., 2022). Lessons learned from the Covid-19 period are surely going to enrich the universities' e-learning protocols, tools, and courses.

As can be seen, the adaptableness and flexibility of the anatomy instructors, the compatibility with the syllabus, and the satisfaction with the assessment methods are major aspects that allowed the continuity of anatomy education programs during the Covid-19 pandemic. Remote delivery of the course positively changed students learning by increasing their self-study time, individual learning

methods, reviewing of lecture videos, navigating scientific research platforms on the internet, and studying with peers. Students used their mobiles (cell phones) to see the anatomy content mostly on Microsoft Teams. Other social media platforms were rarely used except Facebook messenger. This study also presented the successes and challenges of the anatomy and histology course entirely taught online during the Covid-19 lockdown in Jordan. The ease of communication and access to the course facilitated learning from instructors and colleagues through messaging or chatting in Microsoft Teams or Moodle, emailing, or using other educational or social media platforms. As well, the flexibility of time and place enabled students to proceed with their study despite the distance and these features efficiently fit students' needs in the Covid-19 context. The positive impacts of delivering anatomy education online on students' study methods have also been described. However, the challenges in this remotely taught course have been highlighted including difficulty in technical capacity and adaptation to educational platforms. However, these challenges might be overcome by encouraging instructors to record lectures ahead of the livestream and allow subsequent lectures to be for discussion only in addition to providing students with up-to-date education platform tutorials. However, if students are gaining additional skills alongside their anatomical knowledge through exclusively online program remains to be seen.

Limitations of the study

The first limitation of this study is that the sample is not drawn from all Jordanian universities. This was because not all of them offered this course during the lockdown. Second, because the study commenced at the end of the second semester, all students were not able to be reached. Also, since it was an internet-based questionnaire and only delivered in Arabic, students who do not read Arabic did not participate in the study, but bear in mind that only a minority of students do not read Arabic. Third, many students were leaving for their home countries to quarantine, and thus did not feel like filling out the questionnaire. Fourth, although, as mentioned in the methodology section, the questionnaire was reviewed by four independent scientists for validation, and the questionnaire was also revised and filled by ten students. They also were included as participants and re-completed the survey after ten days. Unfortunately, further data analysis was not done to see if the students' previous questionnaire experience biased their responses. Finally, this study was purely focused on descriptive statistics; students were not able to provide free text comments in the questionnaire. Some did provide their opinions before the study took place, and excerpts of their feedback are mentioned in the materials and methods section.

CONCLUSIONS

In conclusion, entirely online anatomy and histology courses in Jordan were a success during the Covid-19 lockdown, yet some

challenges remain. To the best of our knowledge, this is the first study that investigates the effectiveness of the exclusively online-taught anatomy and histology for pharmacy students that also explores the students' perceptions of the educational process student study habits, strengths, and challenges.

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SUPPORTING INFORMATION

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