

Determining Required Teaching Methods in Distance Undergraduate Medical Education Based on the Non-University Learning Methods Medical Students Used During Covid-19: An Exploratory Factor Analysis

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ABSTRACT: In order to improve the distance learning experience for undergraduate medical education, this study aims to evaluate the teaching methods used by universities in Jordan during the distance learning period and identify the best methods in this situation based on non-university educational avenues utilized by medical students during COVID-19. We conducted a survey of 195 medical students from universities across the country using a questionnaire that measures how dependent students are on educational resources provided by universities before and during the distance learning condition and looks into medical students' most used non-university learning methods in face-to-face and distance learning conditions, and the extent to which medical students used them. We found that the main methods used by medical students for non-university learning were non-university educational videos like YouTube videos (92.8%) and non-university textual explanations (i.e., explanations on websites and summaries of materials made by other students) (67.7%). Before the remote learning situation, there was a large reliance on non-university learning materials, which rose significantly during the distance learning situation ($p < 0.001$, $r = 0.54$). We conducted a polychoric correlations-based Exploratory Factor Analysis (EFA) on 10 items, 7 of which were retained in the final model that revealed 2 factors, to analyze the relationship between the universities' educational methods used in distance learning and the non-university methods medical students used. The first factor reflected the change in "students' use of non-university visualization learning methods in distance learning" (external videos, general dependence on non-university methods, and simulation apps had the highest significant loadings (> 0.3)). The second factor reflected the change in "universities' use of visualization and interactive learning methods in distance learning" (deductive discussions, educational videos, and practical methods had significant loadings). A moderately negative correlation was detected between the two factors after applying a Promax rotation ($r = -0.41$), indicating that the decrease in universities' use of visualization and interactive learning aids in connection with insufficient visualization in the distance educational sessions increased students' use of the aforementioned visualized learning methods in distance learning. This study identifies the optimal visual teaching aids to improve distance undergraduate medical education.

KEYWORDS: Distance learning, medical education, non-university learning, teaching methods, visualization.

Introduction

Coronavirus disease 2019 (COVID-19) is a global pandemic that began in December 2019 in the Chinese city of Wuhan [1], before spreading to other regions of the world.

The causative agent for the disease, SARS-CoV-2, has led to different symptoms in the infected people, with respiratory symptoms being the predominant ones [2].

Since that time, many people have been negatively affected by this disease, including university students [3].

Various countries have tried to prevent the spread of this disease through vaccination, and this has led to a reduction in the spread of the disease internationally, despite the presence of people's reluctance to take vaccinations at the beginning of the vaccination process [4].

Many universities around the world have used distance learning to deal with the pandemic [5], and different types of disciplines have been

included in this method of learning, including Medicine.

Let's talk about distance learning in general before delving into the evaluation of the methods used in university medical education, which constitutes the cornerstone for improving distance education in developing, underdeveloped and developed countries.

Distance learning has been defined by Pandza and Masic [6] as the field of education that provides education to students while they are not physically present in traditional classrooms or campuses.

Furthermore, it's the process that indicates the separation of the source of information from the students in space and time.

For many years, distance learning has been a proposed method of learning for medical students and students of different health-oriented disciplines, and is now a popular teaching method in many countries [7,8], with many methods

being used as a way to implement the idea of distance learning in educational systems.

For example, distance learning has been implemented by Jedlicka et al. [9] where video, audio, and chat room methods were tested on occupational therapy students in 2002.

Their study showed a preference for interactive video and audio methods among students.

Another method of distance learning is to give a DVD to medical students who are in the clinical education stage, to watch a lecture and case scenario of an injured patient, instead of giving a face-to-face lecture and case scenario.

The study showed that the results of the OSCE exam for students who had DVDs to learn were better than those of other students, which indicated the positivity of this method [10].

Another method that has been used in distance learning is the virtual microscope, which has been shown to enhance laboratory learning for medical students [11].

Other methods have indicated distance learning using problem-based learning [12], the use of animation [13], and more recently during distance learning conditions due to COVID-19, various platforms and applications to communicate with students (such as ZOOM, Microsoft Teams, YouTube, etc.) [14].

In Jordan, the educational curriculum for a medical student is divided into two phases, the basic medical sciences phase and the clinical phase.

Each stage has a duration of 3 years. Traditionally, in Jordan and other countries, medical education refers to face-to-face lectures in class [6].

Also, medical students who are in the clinical learning stage used to have rounds in hospitals to gain medical learning and experience through patient meetings [15].

Laboratories have been used to teach medical students in Jordan and other countries traditionally besides the methods mentioned.

They have been used in teaching histology, anatomy, physiology, and other materials for medical students.

In Jordan, the distance learning period lasted for more than a year due to COVID-19.

Thus, knowledge about medical students' dependence on non-university learning resources is important in evaluating the methods used for their education in order to develop these methods and to provide a better distance learning experience in any potential situations similar to COVID-19, in the different countries that have

used the distance learning in medical education [16].

Thus, this study aims to evaluate the teaching methods used by universities in teaching medical students before and during the distance learning period in one of the developing countries, Jordan.

The study also aims to determine the medical students' dependence on non-university learning methods before and during the same period, clarifying the methods they use and the methods they prefer to be used by universities in the case of distance learning.

Thus, the study demonstrates the learning methods that medical students need for a better distance learning experience.

This study is the first to discuss the educational methods required in distance medical education based on the non-university learning methods used by medical students.

Methods

To conduct the study, information was collected by questionnaires targeting medical colleges students in Jordan (i.e., students of Jordan University, Jordan University of Science and Technology, Al-Balqa Applied University, Hashemite University, Yarmouk University, and Mutah University), in which they were asked 13 questions.

The questionnaires were designed by Google Forms and were available in Arabic because Jordan is an Arabian country.

The sample size was calculated by the Raosoft sample size calculator (Raosoft© 2004 by Raosoft, Inc.) based on a response distribution of 50%, a confidence level of 95%, and a margin of error of 7%-(1-10%) is selected as margin of error generally in research [17].

A sample size of 195 was appropriate.

The first-year medical students were not included in this research.

The questionnaires were delivered by the students' interactive groups on Facebook, which were established mainly to inform them of the news related to their education.

Demographical questions (i.e., gender, faculty, age, and students' curriculum current-year) were firstly asked.

No identity-related questions were asked, in which no names, e-mails, phone numbers, or other identifying information were asked to be acknowledged by participants.

The design of the survey was depending on the literature related to medical education and distance learning methods used in university education, and depending on the current

perspectives that medical students owe toward distance education, which showed to be unsatisfactory in Jordan [14].

The questions were designed to evaluate the teaching methods used by university professors before and during distance learning, as well as the extent to which students depended on them before and during the same period.

In addition, the study sought to identify the non-university educational resources that students use in medical learning and to find out the extent to which their dependence on them has changed during the distance learning period.

In general, the study sought to determine the optimal methods for medical students in distance medical education.

The answers are designed in a way that suits the nature of the questions asked.

Likert scale (i.e., strongly agree, agree, neutral, disagree, strongly disagree) and Likert-type scale (e.g., increased a lot, increased, no change, decreased, decreased a lot) were used in the design of answers.

Furthermore, different educational methods were mentioned as answers to questions asking about methods students use in non-university education (e.g., Non-university textual explanations (i.e., explanations on websites, summaries of materials from students, similar methods), external (non-university) educational videos (i.e. YouTube videos, other similar sources' videos), simulation apps (i.e., anatomy simulation apps, other simulation apps), medical books, having non-university teaching from a colleague or a non-university teacher).

Moreover, the educational methods professors use in distance and face-to-face education were mentioned as answers to applicable questions (e.g., Presentation of educational slides, educational videos, Practical educational methods (such as attending laboratories or making hospital rotations and meeting patients), deductive discussions).

Data were analyzed using JASP software (Version 0.16.4).

Exploratory Factor Analysis (EFA) was used in the analysis of the Likert items due to the potential of variables to be reduced and constitute 2 factors that relate to each other.

In this research, the factors were extracted through parallel analysis, and an oblique rotation (Promax) was applied to find out a potential correlation between factors.

Furthermore, Cronbachs' alpha was calculated to define internal consistency between

items forming extracted factors, which indicates the reliability of factors.

Frequencies were presented mainly using tables and charts.

To detect if the students' use of non-university learning methods in the distance learning period was significantly higher than before it, Wilcoxon signed-rank test was used.

Furthermore, the Mann-Whitney U test was used to detect if there is a significant difference between the basic and clinical students in the dependence on non-university learning methods during distance learning.

A *p*-value was set at 0.05 for significance, and the effect size was given by the rank biserial correlation (*r*) for the Mann-Whitney U test and Wilcoxon signed-rank test.

The ethical committee of the Faculty of Medicine, Al-Balqa applied university, approved this study.

Consent to participate was obtained from all participating medical students, the objectives of the study were presented on the first page of the questionnaire, and it was stated that filling out the questionnaire constituted consent to participate in the research.

Results

After collecting the data from the participating students, the following results were seen.

The number of participating students was (n=195), of which 102 (52.3%) students were basic-sciences-stage students, and 93 (47.7%) students were clinical-stage students.

Females were the most to participate (111 students (56.9%)) and males were less (84 students (43.1%)).

The mean age for participants was 21.1 years (range, 19-25 years), and the most-participated students were the students of Mutah university with 55 participants (28.2%).

Students of the 2nd year were the most to participate (54 students (27.7%)).

More information about demographics for participants can be seen in Table 1.

Table 1. Demographics.

Age	range=19-25	mean 21.1 years
Gender	Male	84 (43.1%)
	Female	111 (56.9%)
Curriculum Stage	Basic-sciences stage (first 3 years)	102 (52.3%)
	Clinical stage (last 3 years)	93 (47.7%)
Academic year	Second year	54 (27.7%)
	Third year	48 (24.6%)
	Fourth year	50 (25.6%)

	Fifth year	28 (14.4%)
	Sixth year	15 (7.7%)
University	University of Jordan	45 (23.1%)
	Jordan University of Science and Technology	23 (11.8%)
	Al-Balqa' Applied University	44 (22.6%)
	Yarmouk University	20 (10.3%)
	Mutah University	55 (28.2%)
	Hashemite University	8 (4.1%)

Figure 1 shows the teaching methods used by university professors before the beginning of distance learning, as described by medical students.

Figure 2 shows non-university educational methods that students use in non-university learning (self-study) before and during the distance learning period.

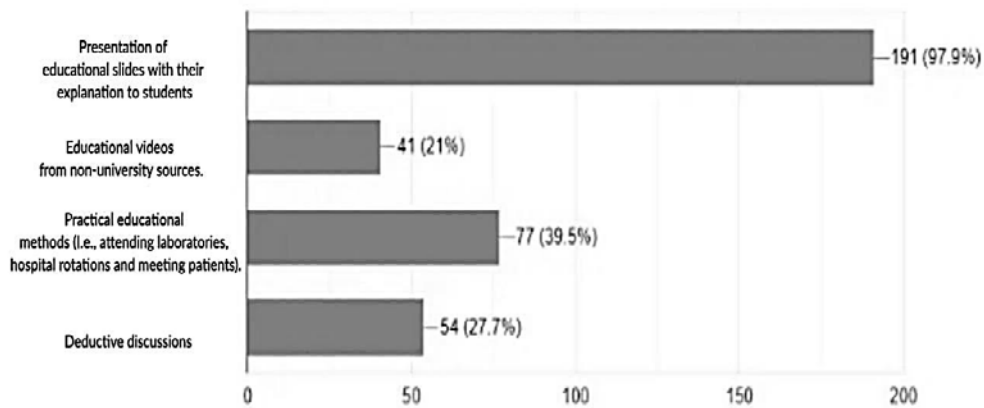


Figure 1. Teaching methods used by university professors before the beginning of distance learning, as described by medical students.

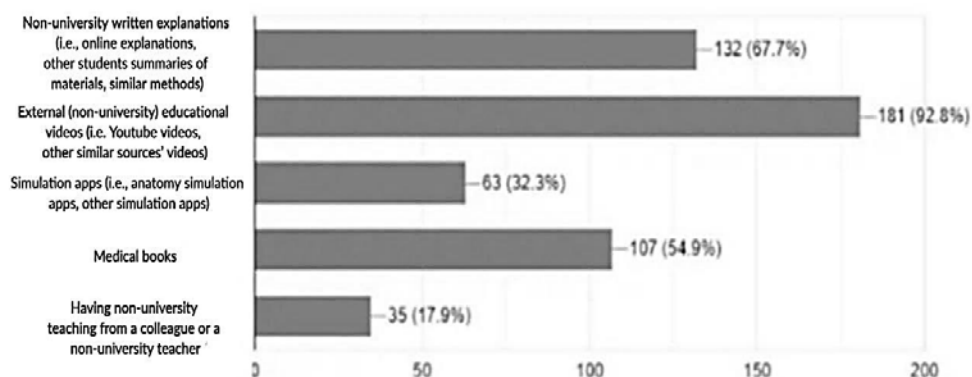


Figure 2. Non-university educational methods that students use in non-university learning before and during the distance learning period. This was addressed to determine the means that medical students use in non-university learning.

Table 2 shows the extent to which students depend on non-university educational methods before the beginning of distance learning and the extent to which it changes during it.

The table also shows how students' dependence on the methods provided by university professors changed during the same period.

This was addressed to determine the extent of the change in students' dependence on non-university and university means of learning during the distance learning period.

A Wilcoxon signed-rank test revealed a statistically significant increase in students' use of non-university learning methods in the distance learning condition with a large effect size ($p < 0.001$, $r = 0.54$, Hodges-Lehmann Estimate = -1).

A Mann-Whitney U test revealed a statistically significant difference between the basic stage and clinical stage students' dependence on non-university learning methods in the distance learning condition, with basic stage students being more dependent ($p = 0.01$, $r = 0.2$, Means: Basic = 4.47, Clinical = 4.22).

Table 2. The extent to which students depend on non-university educational methods before the start of distance learning and the extent to which it changes during it. The table also shows how students' dependence on the methods provided by university professors changed during the same period.

	Very big	Big	Neutral	Small	Very small
Rate of students' dependence on non-university sources before distance learning period begins	56 (28.7%)	88 (45.1%)	28 (14.4%)	19 (9.7%)	4 (2.1%)
	Increased a lot	Increased	No change	Decreased	Decreased a lot
Change in rate of students' dependence on non-university sources for learning during the distance learning period	101 (51.8%)	67 (34.4%)	23 (11.8%)	2 (1.0%)	2 (1.0%)
Change in student's dependence on the university sources for learning during the distance learning period	25 (12.8%)	28 (14.4%)	70 (35.9%)	49 (25.1%)	23 (11.8%)

The following are Tables 3 and 4.

Table 3 shows the extent to which professors' use of usual educational methods changed during the distance learning period of the COVID-19 pandemic.

Table 4 shows the extent to which medical students' use of non-university learning methods changed during distance learning condition.

These findings are important in finding associations used in the evaluation of university educational methods in distance learning.

Table 3. The extent of the change in university professors' use of the teaching methods they used in the usual educational conditions during the distance learning period.

	Increased a lot	Increased	No change	Decreased	Decreased a lot
Presentation of educational slides	69 (35.4%)	41 (21.0%)	73 (37.4%)	10 (5.1%)	2 (1.0%)
Practical educational methods (such as attending laboratories or making hospital rotations and meeting patients)	1 (0.5%)	5 (2.6%)	37 (19%)	57 (29.2%)	95 (48.7%)
Deductive discussion	9 (4.6%)	41 (21%)	64 (32.8%)	39 (20%)	42 (21.5%)
Educational videos	9 (4.6%)	51 (26.2%)	96 (49.2%)	20 (10.3%)	19 (9.7%)

Table 4. The extent of the change in students' dependence on each of the non-university educational methods that they used in the usual educational conditions during the distance learning period.

	Increased a lot	Increased	No change	Decreased	Decreased a lot
Non-university textual explanations (i.e., explanations on websites, summaries of materials from students, similar methods)	36 (18.5%)	70 (35.9%)	75 (38.5%)	11(5.6%)	3 (1.5%)
Non-university educational videos (i.e., YouTube videos, other similar sources' videos)	106 (54.4%)	58 (29.7%)	28 (14.4%)	1(0.5%)	2(1.0%)
Simulation apps (i.e., anatomy simulation apps, other simulation apps)	23 (11.8%)	37 (19%)	120(61.5%)	10 (5.1%)	5(2.6%)
Medical books	33 (16.9%)	68 (34.9%)	75 (38.5%)	15(7.7%)	4(2.1%)
Having non-university teaching from a colleague or a non-university teacher	10(5.1%)	17 (8.7%)	98 (50.3%)	35 (17.95%)	35 (17.95%)

Data were subjected to EFA using the Weighted Least Square (WLS) estimation method and oblique Promax rotation.

All Kaiser-Meyer-Olkin (KMO) values for individual items were well above 0.6, and the overall KMO was 0.67.

Furthermore, fit indices showed a TLI value of 0.982 and RMSEA=0.034, indicating the data were sufficient for EFA.

The Bartlett's test $\chi^2 (21)=288.3, p<0.001$ showed that there was a patterned relationship between the items.

Using parallel analysis, there were 2 factors that explain a cumulative variance of 45%.

The scree plot confirmed the findings of retaining 2 factors.

Table 5 shows the factor loadings after rotation using a significant factor criterion of 0.3.

Accordingly, "educational slides share presentation in DL" and "students' dependence on non-university face-to-face learning by a non-university teacher in DL" were removed from the analysis as they were not significant in our model.

Also “students’ use of medical books in DL” item was removed due to its alteration for model fitness.

For further information see Table 6.

Of note, both of the factors had high internal consistency (Cronbachs’ alpha=0.6 for both).

Table 5. Factors derived from EFA, and their loadings.

Factor Loadings	Factor 1	Factor 2	Uniqueness
university educational videos in DL		0.494	0.779
university practical educational methods (labs or rotations) in DL		0.413	0.802
university deductive discussions in DL		0.930	0.147
students’ use of non-university explanations (like materials, summaries from other students) in DL	0.364		0.830
students’ use of non-university videos (like YouTube) in DL	1.029		0.075
students’ use of simulation apps in DL	0.521		0.689
students’ dependence on external learning methods in DL	0.686		0.555

Note. Applied rotation method is promax.

Table 6. Factors characteristics under rotated solution.

Factor Characteristics			
	Sum Sq. Loadings	Proportion var.	Cumulative
Factor 1	1.862	0.266	0.266
Factor 2	1.260	0.180	0.446

In detail, Four of the Likert items asking about the change in students' use of external (non-university) learning methods during distance learning had strong loadings on factor 1.

Three of the Likert items asking about the change in professors’ use of educational methods during distance learning were correlated to each other.

These items had strong loadings on factor 2.

Depending on the results in Tables 3 and 4, factor 1 reflected the change in “students’ use of non-university visualization learning methods in distance learning” (external videos, general dependence on non-university methods, and simulation apps had significant loadings).

The second factor reflected the change in “universities' use of visualization and interactive learning methods in distance learning” (deductive discussions, educational videos, and practical methods had the highest significant loadings).

These results show the need for better visualization provided by universities in distance learning.

Results revealed a moderate negative correlation between the two factors ($r=-0.41$), indicating that the decreased universities’ use of visualization and interactive methods in distance learning was a cause of students’ increased use of external learning methods-and especially visualization methods-in distance learning.

Discussion

With many universities turning to distance learning in the COVID-19 pandemic, many studies have emerged examining the extent to which medical students are satisfied with distance learning in developing countries.

A study showed that the experience of medical students in distance learning has been unsatisfactory [14].

Another study showed that many medical students in Libya used different types of education methods during the distance learning period, and only one-third of students depended on university lectures [18].

Both of the studies reported the need for better teaching styles in distance learning.

Since evaluating the teaching methods used in distance learning, determining the types of non-university learning methods that students use during distance learning, and determining the extent to which students depend on them are important matters, this study was done.

The results showed that the reliance on non-university educational methods was high before the start of distance education, where there was a great use of the educational slide show method and relatively small use of practical education represented by asking patients or-mostly-attending laboratories by university professors.

This was concurrent with a high level of students’ use of non-university educational methods, especially external educational videos and non-university textual explanations (e.g., other students' summaries and online explanations).

These results are supported by the results of another study that reported medical students’ preference for videos in the educational process [19].

The results showed that the transition to distance education was accompanied by a greater dependence of students on non-university different educational means.

In more detail, there was a decrease in the university professors' use of practical teaching aids (like hospital rotations or laboratory attendance) that was not associated with a suitable use for alternative visualization methods.

Furthermore, the study showed that most of the students said that university professors' use of interactive discussions during distance learning did not change (it remained low) or that it decreased further.

Taken together, these were reasons for the increased student use of external educational videos (like those on YouTube), simulation apps, and external textual learning methods like other students' summaries for materials.

All that means there is a need for more visualization in distance medical education in Jordan.

This indicates a better use of the educational slide presentation method during distance education.

This can be implemented by using tree diagrams, which shown to improve the performance of medical students in diagnosing diseases [20].

Also, images can be used in the slide share by adding keywords to them, this would improve attention, cognition, reflection, and possibly memory retention [21].

In addition, using hyperlinks in the slides (i.e., hyperlinks inserted into slides by professors to allow students to move from one slide to another in the presentation when they click on a predetermined word, shape, or image, thereby providing a more dynamic and interactive experience than can be obtained with a serial presentation of slides alone) would make the learning experience active by allowing students to be more engaged in the presentation [22].

Results also show that there is a need to use other visual teaching aids during distance learning, methods for this will be explained in the next section.

Results also show the need for more deductive discussions in distance learning.

These results are supported by results from other studies showing that the use of group discussion for problem-solving in MBBS new students with facilitation by using adult learning principles needed to be implemented in undergraduate medical education to promote active learning among medical students [23].

Of course, this can be implemented in the case of distance learning by using online meetings that can be done by different applications already used in normal distance learning sessions [14].

How to provide adequate visualization in distance learning?

In general, videos are highly preferred in the field of medical education [19].

Universities can develop videos with specific features to improve distance learning.

That is, videos can be brief, focused on important learning topics, contain audio elements, have notes that are highlighted with specific colors, and have conversational and question-answer styles [23].

These features will also combine visualization with remote deductive discussions in distance learning videos.

Moreover, videos can be made as well-explained direct-teaching videos in which the teacher explains the material on a board that is directed toward a camera, similar to the way used by Khan Academy (i.e., a nonprofit educational website that provides many micro video lectures on different subjects) [24].

This method will also improve the way university professors use the educational slide share method in distance learning.

Also, videos can be made in two-dimensional and three-dimensional forms, like in the case of a first-person perspective way (i.e., videos that are made by a practitioner who films the patient/toy model while examining him and describes procedures for watchers, in which videos are recorded from the eyes of the practitioner), or from a second-person perspective way (i.e., when a secondary practitioner participates as a subject by recording video while interacting with the patient and the primary practitioner).

This way also is done in case of a narrator talks directly to the camera, and the audience is treated as the second character), or from a third-person perspective way (i.e., when a cameraman films the interactions between two persons-like a practitioner and a patient) [25].

Also, animation videos can be used, especially in the clarification of changes with time [13].

Moreover, games can be used as a complementary method-although it is not an on-demand educational method as reported by Gorbanev et al. [26], it can be used in distance learning to help students in this special condition.

For example, it can be used in teaching materials using the Virtual Reality (VR) gamification option [27].

To get a better contribution in the field of visual distance learning, universities can also contract with other international and national universities to exploit the knowledge of many experts in this field to achieve better results with more benefits for more students.

Collaboration can be between medical schools themselves and between them and other IT schools.

Supportive Technologies in a collaborative research framework can be used to provide a structure for using the technologies available to support different schools' collaboration.

Technologies include social media applications, website platforms, and research databases.

Using such technology might help to overcome the physical, logistical and financial barriers to school collaboration [28].

Furthermore, as the need for such collaborations increases, stakeholders need to play a role in collaborations for developing such technologies [29].

Conclusion

The medical student's teaching methods used in universities before the beginning of distance learning conditions showed to be inadequate, and there is a need for more visualization.

The distance learning condition leads medical students to more usage of non-university learning methods, which means inadequacy of universal distance learning methods in distance learning.

The study showed that more visual teaching methods must be provided and better use of the educational slides-share method is required in face-to-face education for the educational system to be better.

Medical students' reliance on non-university learning methods increased during the distance learning period.

The most important reasons for this are the lack of adequate visualization, represented by the low use of practical educational methods (such as asking patients in hospitals and attending laboratories) in conjunction with the inadequacy of the means used by university professors to compensate for that method, such as the inappropriate use of slide presentations and lack of optimal use of visual teaching methods like educational videos.

The most important solutions are the university professors' use of well-prepared videos in the distance learning process in addition to better use of the slide's presentation method (i.e., tree diagrams, more images, slides with hyperlinks, etc.) in addition to more interactive discussions remotely.

Conflict of interests

The authors declare no conflict of interests

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