



## Cross-sectional Study

## Medical students and risk of COVID-19 infection: A descriptive cross-sectional study from the University of Jordan

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## ABSTRACT

**Backgrounds:** The coronavirus disease-2019 (COVID-19) pandemic with increasing morbidity and mortality has impacted the lives of the global population, including medical education. With the return of on-site medical education in Jordan, it is important to know whether this would pose any risk of COVID-19 infection in medical students.

**Objective:** To investigate COVID-19 infection rates among medical students and whether there is difference between preclinical and clinical students' infection rate.

**Methods:** The study is a cross-sectional study, designed to (1) determine the incidence of COVID-19 in clinical and preclinical medical students (2) determine if there is a difference in infection rates between clinical and pre-clinical students. The study was situated at the University of Jordan and its affiliated hospitals. Data were collected from the 4<sup>th</sup> of December 2020 till the 17<sup>th</sup> of February 2021 through a structured web-based questionnaire.

**Results:** A total of 1,830 responses were retrieved. Thirty-nine percent were males, and (61.5%) were females. Overall, 237(13%) of students reported testing positive for COVID-19 infection by PCR, of which 123 were clinical students (15.2%) and 114 were pre-clinical students (11.2%), representing a relative risk of 1.36 of COVID-19 infection among clinical students compared to pre-clinical students. This difference is statistically significant ( $P = 0.010$ ). Rates of COVID-19 in females 13%; CI 7.5,18.4), were very close to those of males (12.9%; 95% CI 6.0,19.8). Positive COVID-19 cases peaked in November and October forming 36.3% and 32.9% of the cases, respectively.

**Conclusion:** The incidence of positive COVID-19 tests was found to be higher among clinical students as compared to pre-clinical students. Commitment to general health safety precautions did not appear to be protective enough for clinical students. It is fundamental that additional strategies, including access to vaccines, are set, and deficiencies in current protections are identified to maintain students' safety and well-being.

### 1. Introduction

A novel respiratory disease has been reported in late December 2019 in Wuhan a city of the Hubei Province of China, and it is now underlined by WHO (World Health Organization) as coronavirus disease-2019 (COVID-19) [1]. In early March 2020 the first case of COVID-19 was reported in Jordan [2]. As of the 26<sup>th</sup> of March 2021 a total of almost 571,300 diagnosed cases were reported with 6280 deaths in Jordan [3].

The COVID-19 pandemic has caused major disruptions in different fields of life activities including the education process. Until the 27<sup>th</sup> of May 2020, more than 990 million learners in all levels of education, including university students, have been affected due to the suspension of many person-to-person activities in academic institutions in many countries all over the world [4]. Despite the major suspension of on-site student participation in public universities in Jordan by the beginning of the pandemic [5], education in medical schools has returned under strict

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special regulations in efforts to minimize transmission of the virus while offering proper training.

Not only are students who are taking clinical practical courses at an increased risk of infection [6], but medical students may contribute to the spread of the disease as asymptomatic carriers [7]. This, in combination with the global shortage of personal protective equipment [8], and vaccination challenges may put medical students at special risk for infection.

In this study we aim to estimate the incidence positive COVID-19 tests in medical students in the University of Jordan, comparing pre-clinical to clinical students, and to provide insight into the perceived routes of infection in medical students.

## 2. Methodology

### 2.1. Study design and study population

The study is a cross-sectional study type, designed to (1) determine the incidence of COVID-19 infection in clinical students who received blended learning with in hospital sessions and patients contact and preclinical medical students who received only distant learning (2) determine if there is a difference in infection rates between clinical and preclinical students. The study was situated at the University of Jordan and its affiliated hospitals. Data was collected from the 4<sup>th</sup> of December 2020 till the 17<sup>th</sup> of February 2021.

### 2.2. COVID-19 testing

As a policy in JUH and the Jordanian ministry of health, anyone who was in contact with a positive COVID-19 case or developed symptoms suggesting COVID-19 infection was offered a COVID-19 test by PCR. Hence, all COVID-19 infections among the medical students were confirmed by PCR testing. Antibody testing for COVID-19 was not available in Jordan at the time of the conduction of this study.

Data was collected using a structured web-based questionnaire created using Microsoft Teams was shared with all students through Microsoft Teams groups, and students were only able to access the questionnaire through their ID number to avoid duplications. All the subjects were guaranteed anonymity and privacy to their data entries. Questions mainly focused on students' demographics, and on their COVID-19 status and experience. Targeted groups were basic (2nd and 3rd year) and clinical (4th, 5th and 6th year) medical students attending the University of Jordan during the academic year (2020/2021).

### 2.3. Statistical analysis

Data frequencies (i.e. descriptive statistics) of the whole study sample as well as divided by clinical and preclinical were counted on Microsoft Excel. A chi-square test was used to compare frequencies of positive COVID-19 test results between preclinical and clinical medical students. We calculated the risk difference of infection between pre-clinical and clinical groups and obtained 95% confidence intervals.

We also compared infected preclinical and clinical students in relation to clinical characteristics using Fisher's Exact test, and compared clinical students with positive COVID-19 test results and those without in relation to hospital attendance and time spent in the hospital using the independent sample *t*-test.

These tests were conducted using the Statistical Package for Social Sciences (SPSS) version 25 (Chicago, USA). A  $P < 0.05$  was considered statistically significant. The study is reported adhering to the STROCCSS 2019 statement on reporting of cohort studies [9].

### 2.4. Ethical consideration

The study was approved by the University of Jordan Hospital Institutional Review Boards (IRB) and all subjects were provided with either

electronic written or verbal informed consent prior to data collection. The research team assigned participants using their university identification numbers rather than names to maintain privacy and anonymity.

## 3. Results

A total of 1,830 responses were retrieved from second to final years of medical education, with an overall response rate of 70.3%. Of the 1,830 participants, 705 (38.5%) were males, 1125 (61.5%) were females (Table 1). Most of the participants (55.8%,  $n = 1022$ ) were pre-clinical students while clinical students comprised about 44.2% ( $n = 808$ )

Overall, 237(13%) students reported testing positive for COVID-19 infection, of which 123 were clinical students (15.2%; 95% CI 8.9,21.5) and 114 were pre-clinical students (11.2%; 95% CI 5.4,17), representing a relative risk of 1.36 (95% CI 1.08,1.73) of COVID-19 infection among clinical students compared to pre-clinical students. This difference is statistically significant ( $P = 0.010$ ). Rates of positive COVID-19 infection in females 13%; CI 7.5,18.4), were very close to those of males (12.9%; 95% CI 6.0,19.8)

Positive COVID-19 cases peaked in November and October forming 36.3% and 32.9% of the cases respectively (Fig. 1)

Most clinical students who reported positive results reported having rotated on-site in the hospital immediately before the infection (69.9%,  $n = 86$ ). Only (27.9%) of these, however, think they got the infection from their visits to the hospital, while 32.6% think they got the infection from home and 17.4% think they got the infection elsewhere.

Self-reported complete commitment to the standard safety precautions for limiting the transmission of COVID-19 (Personal protection, social distancing, and hand Hygiene) (Table 2) reached 43.9% of infected pre-clinical students. This is in contrary to the 66.7% reported in clinical students who tested positive for COVID-19.

There appears to be no significant difference between clinical and preclinical students when it comes to the hospitalization rates (Table 3)

A detailed look into the distribution of COVID-19 infection among different patterns of attendance to on-site hospital duties of clinical studies shows higher percentages of infection among those spending more than 5 daily hours in the hospital (27% infection rate) (Fig. 2). On the other hand, the change in number of weekly days spent in the hospital did not produce a huge difference in infection rates (interquartile range of 17.35%–6.2%). It is worthy of mentioning that only 29 clinical students (3.6%) reported spending more than 5 daily hours in the hospital. Eight of them (27.6%) have tested positive for COVID-19.

There is no significant difference in mean hospital attendance and mean time spent in the hospital between clinical students that tested positive for COVID-19 and those who did not (Table 4).

**Table (1)**

Distribution of participants according to academic level and gender

		Gender		Total
		Female	Male	
Academic level	Sixth year (clinical)	n 157	63	220
		% 71.4%	28.6%	100.0%
	Fifth year (clinical)	n 154	149	303
		% 50.8%	49.2%	100.0%
	Fourth year (clinical)	n 179	106	285
		% 62.8%	37.2%	100.0%
Third year (pre-clinical)	n 249	195	444	
		% 56.1%	43.9%	100.0%
	Second year (pre-clinical)	n 386	192	578
		% 66.8%	33.2%	100.0%
Total	n 1125	705	1830	
	% 61.5%	38.5%	100.0%	

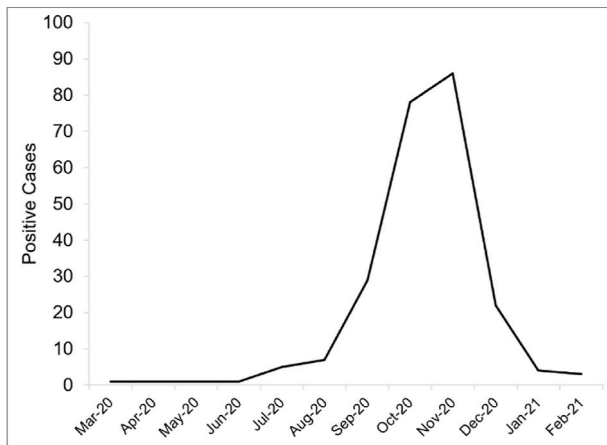


Figure (1). Positive cases represented by time.

Table (2) Commitment to standard general health safety precautions in COVID-19 positive participants. † (Personal protection, social distancing, and hand Hygiene).

	Total positive cases (n = 237)	Pre-clinical students (n = 114; 48.1%)	Clinical students (n = 123; 51.9%)
Close distance to an infected or possibly infected person	176 (74.3%)	86 (75.4%)	90 (73.2%)
Not wearing masks or wearing masks improperly (in a way that does not cover the mouth and nose completely)	48 (20.3%)	32 (28.1%)	16 (13%)
Complete commitment to precautions at public areas including the hospital. †	132 (55.7%)	50 (43.9%)	82 (66.7%)

Table (3) Clinical characteristics of COVID-19 positive participants.

		All COVID-19 positive students (Academic level)		Total n = 237 (100%)	P-value*
		Pre-clinical n = 114 (48.1%)	Clinical n = 123 (51.9%)		
Developed COVID-19 symptoms	n	97	114	211	0.095
	%	85.1%	92.7%	89.0%	
Needed hospitalization	n	7	3	10	0.202
	%	6.1%	2.4%	4.2%	
Took medications at home	n	75	88	163	0.400
	%	65.8%	71.5%	68.8%	

\* Fisher's Exact Test.

4. Discussion

Among 1830 participants, 237 students (13%) tested positive for COVID-19. These include 15.2% of clinical students and 11.2% of pre-clinical students. These results support the hypothesis of higher COVID-19 incidence in clinical students compared to pre-clinical students. This difference may be attributable to studying or work environment as clinical students are more likely to interact with COVID-19 infected patients. A Danish study has concluded that the risk of infection among medical students is only partly related to working with COVID-19 infected patients, but is rather greatly related to their social behaviors [9]. This might also explain the high percentage of clinical students who were rotating in wards prior to testing positive thinking they got the

infection from outside of the hospital (50%) in our study. A similar assumption was made by a group of researchers studying the seroprevalence of anti-COVID-19 antibodies among clinic staff, when none of the nurses (who have the closest and longest contact with patients in comparison to other clinic employees) turned out to be seropositive [10].

It is important to understand how clinical medical students and healthcare workers are exposed to the virus to provide the proper protection [11]. In our study, 27.9% of infected clinical students who were rotating in the hospital before contracting the infection think they got the infection from hospital visits. On the other hand, 32.6% think they got it from home. This might be because most of the students (82.1%) live with their families. This, combined with the average household size of 5.5 individuals in Jordanian families [12] increases the possibility of catching the virus from a household member.

This is in contrary to the results of studies in China, where 84–89% of infected hospital personnel think they got the infection from their work environment [11,13].

Regarding the hours spent in the hospital, it is known that long duty hours (15 h or more per day) are also associated with increased risk of infection in healthcare workers [14]. In one study, almost 45% of COVID-19 infected health care workers reported working more than 7 h/day [11]. In our study, only 6.5% of COVID-19 infected students reported spending more than 5 h/day in the hospital. This can be explained by the unlikelihood of medical students to spend long hours in the hospital [15], as only 3.6% of clinical students in our study reported spending more than five daily hours in the hospital.

A considerable inter-hospital variation is apparent in our study results, as 8.6% of students rotating in JUH contracted the infection in comparison to 3% of clinical students rotating in the other affiliated hospitals. This may be attributable to the more participation in clinical activities in JUH, Differences in hospital policies and practices may also play a role.

In our study, Self-reported complete commitment to the standard safety precautions for limiting the transmission of COVID-19 reached 43.9% of pre-clinical students who tested positive for COVID-19. This is in contrary to the 66.7% reported in clinical students who tested positive for COVID-19. This suggests that clinical students remain susceptible to COVID-19 infection even if committed to the general safety precautions. It is also supported by the results of a previous research conducted on medical students in Jordan that showed that clinical students are significantly more likely to use disinfectants in general and to disinfect their mobile phones as a protective measure against getting infected. However, the previously reported alarming percentage (64.3%–56.1%) of students in Jordan not wearing a mask as a precautionary measure against COVID-19 [5] has dropped in our study to (28.1%–13%). This is probably due to increased awareness, changes in policies, and the increase in COVID-19 cases in Jordan, which have raised concerns in the public and motivated them to take more serious efforts to prevent the transmission of the virus.

An apparent increase in the rate of reported COVID-19 positive tests in our study participants was seen in October and November, which was consistent with the sharp increase in confirmed positive cases in Jordan (MOH, 2021) (Fig. 3). However, another increase in cases in Jordan starting in January was not associated with a rise in positive cases in our study participants because most participants were recruited, and the data collected in December. Temporal trends of COVID-19 test in healthcare workers mirroring those of the general population in the region was reported in other studies as well [16,17]. Whether this signifies a greater role of community transmission rather than hospital-based exposure, needs further investigation [18].

Considering our study results, it is apparent that clinical students are at increased risk of contracting the virus, recent literature has conflicting views on whether medical students should be allowed to proceed with clinical rotations in hospitals throughout the pandemic. A study argued that medical students are non-essential in health-care facilities and that

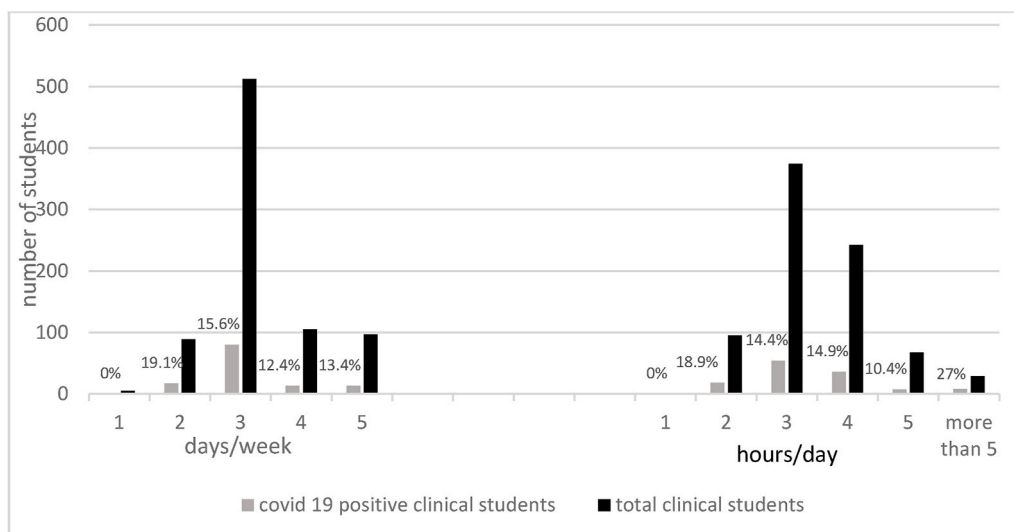


Figure (2). Rates of COVID-19 infection among clinical students according to time spent in the hospital.

Table (4) Rates of COVID-19- infection among clinical students. JUH; Jordan University Hospital.

	Total clinical students (n = 808)	# SARS-Co-V-2 + (n = 123; 15.2%)
Hospitals rotated in JUH	806	69 (8.6%)
Other affiliated hospitals	558	17 (3%)
Estimated average weekly hours spent in the hospital		
1–10	424	66 (15.6%)
11–20	351	53 (15.1%)
>20	33	4 (12.1%)

personal protective equipment [19]. However, a study showed that 83.4% of medical students were willing to accept the risk of infection with COVID-19 if they returned to the clinical rotations and another indicated that two-thirds of students favored the return [20,21].

Clinical students’ safety could be promoted through prioritizing their vaccination and providing proper education on the use and importance of protective personal equipment and hygiene in hospital settings. Application of protective measures will potentially prevent transmission of COVID-19 infection to others [22]. A study in Jordan showed that 75.0% of medical students believed that an effective vaccine would halt the spread of COVID-19, indicating willingness of clinical students to receive the vaccine if given access to it [5].

Strengths of this study include high participation (70% of the medical students at the University of Jordan) and the large sample size (1830 students). All medical students were invited to participate regardless of COVID-19 status. Major limitations of this study include the data collection duration not being short enough to ensure the limitation of the possibility of new cases emerging throughout the process. Some students could have been asymptomatic COVID-19 patients that were unaware of their infection, and therefore our reported positive cases are an under-estimation of the actual number. In addition, as a retrospective observational study, we cannot precisely identify the exposure leading to infection. Furthermore, data were self-reported which allows for misclassification.

5. Conclusion

In summary, in a cross-sectional study, the incidence of positive COVID-19 tests was found to be higher among clinical students as compared to pre-clinical students. Commitment to general health safety precautions did not appear to be protective enough for clinical students. Most infected participants reported no need for hospitalization. It is fundamental that additional strategies are set and deficiencies in current protections are identified to maintain students’ safety and well-being. With the recent availability of the COVID-19 vaccine, clinical medical students as well as healthcare workers should be given priority to receive the vaccine.

Ethical approval

Approval Has been taken from the Jordan University Hospital’s committee Number: 2021/47.

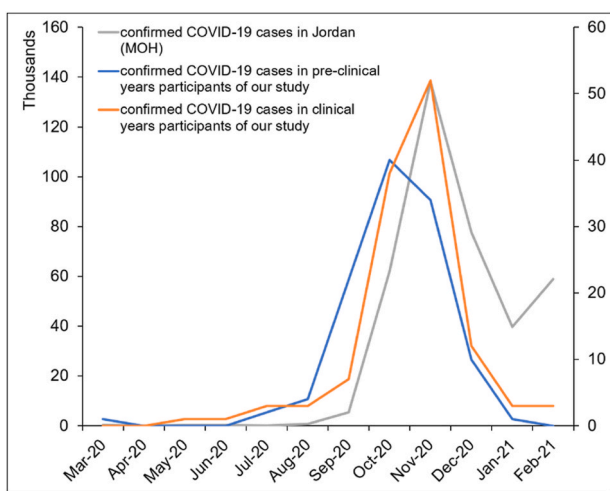


Figure (3). Incidence of COVID-19 infection distributed by month between (March 2020–February 2021). The left y-axis shows number of monthly new COVID-19 positive patients in Jordan, derived from the COVID-19 statistical report of the Ministry of Health, Jordan (grey line). The right y-axis shows the number of COVID-19 positive tests in pre-clinical students participating in our study (blue line) and the number of COVID-19 positive tests in clinical students (orange line) [3]. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

they simply increase transmission of COVID-19 and waste limited



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This research has no Funding.

## Author contribution

Amjad Bani Hani conceived the original idea and supervised the findings of this work. Rama Rayyan, Laila Alhafez and Amer Kamal performed the data collection and wrote the manuscript with support from Mahmoud Abu Abeele. Nader Alaridah performed the data analysis and interpretation, Amjad Shatarat and Rasha Odeh did Critical revision of the article and Raed Al-Taher drafted the manuscript and designed the figures. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

## Registration of research studies

- 1 Name of the registry: [ClinicalTrials.gov](https://clinicaltrials.gov)
- 2 Unique Identifying number or registration ID: NCT04967586
- 3 Hyperlink to your specific registration (must be publicly accessible and will be checked):

<https://clinicaltrials.gov/ct2/results?cond = &term = NCT04967586&cntry = &state = &city = &dist =>

## Consent

Consent has been obtained.

## Guarantor

Amjad Bani Hani.

## Provenance and peer review

Not commissioned, externally peer reviewed.

## Declaration of competing interest

All Authors have no conflict of interest to declare.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.102775>.

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