Original Article

The Impact of COVID-19 on The Teaching of Non-Medical Healthcare Professionals in Bangladesh: Observations and Implications From A Pilot Study

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Abstract

Objective: At the start of the Covid-19 pandemic, educational establishments, including universities, were closed. Educators in high-income countries quickly shifted all education online, building on available infrastructures and approaches. However, there were concerns in developing countries regarding the necessary skills among students and faculty as well as financial support for equipment and the internet. Consequently, a pilot was undertaken in Bangladesh to determine the impact of Covid-19 on the non-medical education system, building on similar research with healthcare professionals. Materials and Methods: A purposively designed questionnaire was disseminated among eight non-medical healthcare educators in private and public universities in Bangladesh. Results and Discussion: Private university educators reported their universities readily adopted e-learning systems and resumed classes more quickly than public universities. Both private and public university educators shared similar challenges, including a lack of training on e-learning initially, variable internet connections, affordability of internet bundles, concerns with available devices, as well as mental stress of faculty and students. Private universities reduced their tuition fees, extended submission deadlines, and shared class recordings to address challenges. Public universities arranged student loans, established Covid-19 testing centers, and the trained students in biosafety practices and molecular tests to volunteer in testing facilities. Conclusion: Lessons learned from the pandemic emphasize introducing hybrid education systems with full technological and financial support, alongside biosafety education in the curriculum.

Keywords: Bangladesh, e-learning, non-medical healthcare educators, Covid-19, hybrid education system.

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Introduction

Covid-19 is a highly pathogenic contagious viral disease that has resulted in severe morbidity and mortality across countries 1,2, resulting in over 516 million cases and over 6 million deaths by 13 May 2022 3. In the absence of effective treatments for the prevention and management of patients with Covid-19 at the start of the pandemic, including effective vaccines, countries typically introduce a variety of lockdown and other measures to control its spread 4-8. However, the rapidity of their implementation, coupled with the stringency of their enforcement, impact morbidity and mortality rates in practice across countries, certainly in the early phase of the pandemic 4, 9-12. Bangladesh was no exception introducing several lockdowns and other measures at the start of the pandemic 13,14. Initiatives included the closure of educational establishments, including universities 13-16, with these measures subsequently having an appreciable impact on educational sectors 14, 17. Universities typically need to postpone or immediately cancel all campus-related activities. All face-to-face teaching-learning programs and other academic activities, such as conferences, workshops, and sports activities, were also typically halted in the initial days following the Covid-19 16-19. Subsequently, globally traditional face-to-face teaching was replaced by online or e-learning programs across countries 19-21.

Online education, or e-learning, is a subcategory of a distance learning system that denotes educational models utilizing information technologies to provide teaching-learning instruction to pupils in variable locations, which was necessary following the closure of universities 22,23. However, this raised many issues, especially among low- and middle-income countries (LMICs), which included inadequate training of faculty members beforehand in e-learning techniques, affordability of internet bundles and computer equipment among students, and quiet locations for

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studying (Figure 1) 19,21,24,25. This was less of an issue among high-income countries with typically greater utilization of online teaching-learning instructional methods before the pandemic, better availability of necessary equipment, and affordability of internet bundles 20,21,26-28.

It has been reported that Bangladesh and many other LMICs had limited experience with online learning at the start of the Covid-19 pandemic among academic staff and students and poor internet access, and high prices for the internet 19, 21, 29. Other studies have revealed that improved faculty training on e-learning among LMICs, students supported financially to purchase the necessary equipment and internet bundles, launching Covid-19 prevention protocols including providing protective equipment, video-recorded lectures, tutorials to make up for a lost time, and simulated methods to teach clinical aspects, have all helped address identified barriers, with hybrid approaches to learning likely to stay 19, 21, 30-32. Other identified issues include addressing stress and mental health issues 16, 19, 23.

It is essential in LMICs, including Bangladesh, with its high burden of infectious and non-infectious diseases 10, 13, 16, 33-37, to ensure healthcare professionals (HCPs), including non-medical, are fully trained on graduation. The alternative is continued increases in morbidity, mortality, and associated costs with inappropriate use of antimicrobials and sub-optimal management of chronic non-communicable diseases, including diabetes 37-42.

Consequently, this study aims to assess non-medical HCP academic staff perceptions regarding the current challenges of Covid-19 on online teaching systems. This builds on the earlier study regarding dental and medical education in Bangladesh following the closure of universities in Bangladesh and similar studies in other LMICs 16,19,21,31,43.

2. Materials and Methods
2.1. Approach
This study used a pragmatic approach to ascertain and review challenges and difficulties regarding teaching non-medical HCPs at the start of the pandemic 44-46. This is because pragmatism allows an adaptable and thoroughly instinctive research strategy, thereby logically holding deductive and inductive form judgments 47, 48. Consequently, we believed the current research methodology was the most relevant to address such critical research questions 49.

Non-probability sampling was utilized for this pilot study based on the expert knowledge of the co-authors, who are themselves non-medical health professionals.
professional educators. This improved the capacity to acquire a rich data source from a limited sample. To augment the study’s credibility, transferability, and dependability, a data source triangulation method was used with participants from non-medical and other health professional disciplines. The initial sample of eight participants included five educators from public and three from private universities to ensure complete coverage, similar to the previous pilot study in Bangladesh. The participants covered various subjects, including microbiology, pharmacy, Biotechnology & Genetic Engineering. No students participated in this pilot study as we wanted to gain an understanding from the educators first.

A qualitative semi-structured questionnaire was adopted based on recent research conducted among African and Asian countries. Respondents had enough time to construct and amend their answers before being sent back. Participants were encouraged to remain in constant communication with the researchers to clarify any details regarding the research as needs arose.

The questionnaire consisted of four main open-ended questions coupled with prompt questions. The main questions focused on the challenges presented by the Covid-19 pandemic, the response and support the educators and their universities provided to address them, and lessons learned for future pandemics. These four questions included:

I. What challenges has Covid-19 presented to HCP education in Bangladesh?

II. How did your university/institution respond immediately to the challenges presented by the Covid-19 pandemic?

III. What support was harnessed to help mitigate the challenges faced by your higher learning institution?

IV. What lessons can be learned to prepare HCP educators for non-medical HCPs in Bangladesh for future pandemics?

2.2. Analysis

A framework method of data analysis was applied, similar to previous studies, which provides a detailed outline of individual observations and enables themes to develop deductively and emerge inductively from participants’ experiences and views.

The main themes from the responses were predetermined deductively by the research questions and stored using different sheets of Microsoft Excel. The further analysis relied on inductive reasoning in which sub-themes emerged through repeated evaluation of the questionnaire data. Initially, one research team member independently coded the responses (KC) from the same eight questionnaires and subsequently developed a set of codes to form the initial analytical framework. Some of the codes were later grouped into categories. Several codes were subsequently mapped using diagrams to explore the relationship between the subthemes. In addition, patterns among the different types of participants were identified.

2.3 Ethical Considerations

Ethical approval was not needed for the study, similar to other pilot studies and similar studies conducted by the co-authors in the absence of patients. However, written informed consent was taken from the participants before starting the pilot project to ensure that they fully comprehended all aspects of the study and voluntarily agreed to participate. Participants were subsequently informed that their identities would be kept confidential, guaranteeing respect for autonomy and trust.

3. Results

We will first document the participants’ demographic details (Table 1) before discussing key and additional challenges faced by the non-medical HCPs at the start of the pandemic (Tables 2 and 3).

Table 1: Demographic Characteristics of Participants.

| University                                      | Type of University | Department                          |
|------------------------------------------------|--------------------|-------------------------------------|
| Jahangirnagar University                        | Public             | Microbiology                        |
| Noakhali Science and Technology University      | Public             | Microbiology                        |
| Mawlana Bhashani Science and Technology University | Public             | Pharmacy                            |
| Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Gopalganj | Public             | Biotechnology & Genetic Engineering |
| Comilla University                              | Public             | Pharmacy                            |
| BRAC University                                 | Private            | Pharmacy                            |
| Stamford University                              | Private            | Microbiology                        |
| Prime Asia University                           | Private            | Microbiology                        |
Table 2 discusses the top six challenges reported by faculty members teaching non-medical HCPs at the pandemic based on their replies to the various questions. Table 3 discusses additional challenges that emerged from the study.

Table 2: Summary of Top Six Challenges Reported by participating HCPs

| Institutions | Lack of practical training | Interruption of research project due to scarcity of funding | One-way interaction | Fear and anxiety | Lack of training on e-learning | Poor Internet Connection |
|--------------|---------------------------|-------------------------------------------------|---------------------|----------------|--------------------------------|-------------------------|
| Public-1     | ✓                         | ✓                                               | ✓                   | ✓              | ✓                              | ✓                       |
| Public-2     | ✓                         | ✓                                               | ✓                   | ✓              |                                | ✓                       |
| Public-3     | ✓                         | ✓                                               | ✓                   | ✓              |                                | ✓                       |
| Public-4     | ✓                         |                                                |                     |                |                                | ✓                       |
| Public-5     | ✓                         |                                                |                     |                |                                | ✓                       |
| Private-1    |                           |                                                 |                     |                |                                | ✓                       |
| Private-2    |                           |                                                 |                     |                |                                | ✓                       |
| Private-3    | ✓                         |                                                |                     |                |                                | ✓                       |

Table 3: Additional challenges Faculty members and students face at the start of the pandemic.

| Questions                                                                 | Non-Medical Health Care Professional Institutions                                                                                   | Total                |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Did all students have access to the necessary equipment, e.g., computers, etc., |                                                                                                                                     | No (8, 100%)         |
| Could all students afford the various internet bundles to undertake eLearning | No (5, 100%)                                                                                                                      | Yes (1, 12.5%)       |
| Any courses/ tutorials instigated early in the pandemic for the teachers to become familiar with new platforms such as Zoom. | No (5, 100%)                                                                                                                      | Yes (4, 50%)         |
| Were there any challenges with students undertaking eLearning at home     | Yes (5, 100%), e.g., poor Internet connection, family chaos, costly Internet bundles, inadequate devices, conflicting time schedules | Yes (8, 100%)        |
| Due to the pandemic, have any support services been introduced for students and lecturers? | Yes (2, 40%), e.g., loans for students and teachers to buy ICT products and arrangement of online class No (3, 60%) | Yes (5, 62.5%)       |

There were various immediate responses to the challenges of e-learning and taking safety measures among the educators and students. These included concerns among students with the potential financing of home computers/smartphones and internet bundles. In addition, addressing limited knowledge regarding e-learning approaches among faculty members at the start of the pandemic (Table 4).
Table 4: Summary of Top Six Immediate Responses among the non-medical HCP educators at the start of the pandemic.

| Institutions | Online classes and exams on theory courses | Training of faculty members on online teaching | Covid-19 awareness program and training | Student loan | Started manufacturing hand sanitizers | Establishment of the COVID-19 test center, including the availability of rt-PCR test |
|--------------|-------------------------------------------|-----------------------------------------------|----------------------------------------|--------------|--------------------------------------|--------------------------------------------------------------------------------|
| Public-1     | √                                         | √                                            |                                        |              |                                      |                                                                                |
| Public-2     | √                                         |                                               |                                        |              |                                      |                                                                                |
| Public-3     | √                                         |                                               |                                        |              |                                      |                                                                                |
| Public-4     |                                            | √                                            | √                                      |              | √                                    |                                                                                |
| Public-5     |                                            | √                                            |                                        |              |                                      |                                                                                |
| Private-1    |                                            |                                               |                                        |              |                                      |                                                                                |
| Private-2    |                                            |                                               |                                        |              |                                      |                                                                                |
| Private-3    |                                            |                                               |                                        |              | √                                    |                                                                                |

There were several responses among the universities to assist students and faculty members with e-learning approaches during the initial stages of the pandemic. These are summarized in Table 5.

Table 5: Examples of Support and Other Measures among the Targeted Universities in Bangladesh in Response to The Pandemic.

| Support                                               | Total Number and Percentage (n = 8) | Number of Universities |
|-------------------------------------------------------|-------------------------------------|------------------------|
| Financial support for students                        | 5 (62.5%)                           | Public 2 Private 3     |
| Shifting the in-person class system into digital teaching-learning | 4 (50%)                             | Public 3 Private 1     |
| Several psychological support campaigns for mentally stressed students | 2 (25%)                             | Public 1 Private 1     |
| Proving training to faculties for digital teaching-learning system | 2 (25%)                             | Public 2 Private 0     |
| Arrangement of online webinars, workshops, etc. to exchange knowledge | 2 (25%)                             | Public 1 Private 1     |
| Computers and mobiles were made more accessible for the faculty members | 1 (12.5%)                           | Public 0 Private 1     |
| Awareness program among teachers, students, and community members regarding prevention of COVID 19 transmission | 1 (12.5%)                           | Public 1 Private 0     |

Examples of financial support mentioned by the participants included reduced accommodation fees,
arrangements of loans to students to enable them to buy ICT devices, and reduced tuition fees (25%) to support the internet costs.

There were also several lessons learned about educating non-medical HCPs students during the early stages of the pandemic (Table 6). These developments facilitate hybrid learning approaches in the future, with such strategies likely to stay.

**Table 6:** Lessons learned among personnel from the eight Universities.

| Colleges | Lessons Learned |
|----------|-----------------|
| Public 1 | • There should have a dedicated infection control unit for each higher learning institution  
• Teachers, students, and nearby communities should be trained periodically about potential pandemic infection control measurements.  
• The infrastructure of the virtual education system should be built properly so that education can be continued in any unforeseen pandemic situation  
• Some subsidized digital equipment should be made available for students during any future pandemic  
• Sufficient training should be provided to teachers and students so that they can rapidly adapt to digital teaching-learning in any future pandemic |
| Public 2 | • Online based education advancement  
• Universities’ website improvement  
• Developing international communication and collaboration to learn from each other  
• Funding extension for education sectors  
• Research laboratory build-up |
| Public 3 | • Online education improvement  
• Digital platform development  
• Funding extension for education sectors  
• Awareness and preparedness for other pandemics |
| Public 4 | • Students’ accommodation with individual seats  
• Training for online activities  
• Online-offline hybrid education improvement  
• Funding extension for educational sectors  
• Research laboratories refined to deal with future pandemics |
| Public 5 | • The education curriculum must be updated  
• Offline and online-based assessment techniques must be implemented  
• Assessment criteria and process must be revised  
• Digital education systems and techniques must be available for all students |
| Private 1 | • The online platform should be continued to some extent  
• Academic sessions should not be hampered by the pandemic  
• 30% of the student classes can be taken online |
| Private 2 | • The hybrid education system is here to stay |
| Private 3 | • Introduction of primary health sciences education in schools  
• Cross-training between different health sciences education division  
• More accessibility to computers and electronic devices for learning |

**Discussion**

Similar to other nations and continents, the pandemic severely disrupted traditional educational approaches in Bangladesh.16,17,61,62. There were significant hurdles to be addressed to fully prepare non-medical HCPs in Bangladesh for their activities post qualification at the onset of the pandemic, which was similar to other LMICs.63-65. The topmost challenges among private and public universities (Table 2) included a lack of prior training regarding e-learning approaches and tools before the pandemic. However, this was more prevalent among public versus private universities. Educators from other LMICs 19,43,61,65,66 also faced this challenge. There was also a scarcity of funding and the ability to undertake a research project at the start of the pandemic; however, again, this mainly
occurred among public versus private universities. Of concern was that most students, particularly among public universities, did not have access to a computer and other required equipment or could afford the various internet packages for e-learning at the start of the pandemic (Table 3). Most of the non-medical HCP educators in the public sector were also unfamiliar with online meeting platforms during the early stages of the pandemic (Table 2). Furthermore, when educators undertook classes from home, they encountered problems, including internet outages due to inadequate connections. This was also a major concern among education across Africa and other LMICs; however, potentially less of an issue in India, Arabia and other high-income countries, which had already made significant investments in e-learning approaches before the pandemic, smoothing the transition from in-person to online learning at the pandemic.

Other key issues that arose at the start of the pandemic included non-medical HCP educators concerned that students lacked adequate feedback for studies or projects, exacerbated by the inability to undertake complete supervision. There was also a need to ensure a calm and quiet environment at home for teaching and learning. This is recognized as more challenging in LMICs, especially when all family members, including children, are forced to stay at home in cramped conditions during successive lockdowns causing turmoil and distraction. Students also lost touch with their classmates and teachers, and faculty members have also lost touch with their students and colleagues.

These issues had a significant psychological and emotional impact on both educators and students in Bangladesh and across countries (Table 5), with the mental stress caused needing to be addressed going forward. This has been helped in Bangladesh by private universities providing full support to their students and faculty members through scheduling counseling sessions to inspire and build mental strength and minimize stress, which has proved beneficial. Other activities (Table 5) include helping with tuition fees and relaxing the submission deadline. Public universities have also assisted their teachers and students through arranging loans to purchase ICT equipment, similar to examples across Africa.

Overall, educators in Bangladesh were quick to adapt to the online learning mode at the start of the pandemic. However, initial challenges included skill development and the necessary digital infrastructure. The universities typically provide webinars and online workshops to exchange and update knowledge (Tables 4 and 5). Public universities also established Covid-19 awareness programs and transmission prevention training by making hand sanitizers and distributing masks. One private and one public university also established Covid-19 sample collection booths and performed RT-PCR tests, a confirmatory test for Covid-19. Moreover, non-medical HCP educators, specifically microbiologists, trained their students for Covid-19 diagnosis, who later became volunteers at the RT-PCR testing facility across Bangladesh. We also observed that the experiences and challenges posed by the Covid-19 pandemic on the non-medical healthcare professional are not unique but related to studies in other LMIC countries on medical healthcare professionals.

Lessons learned from this pandemic will provide suggestions to deal with the future pandemic. Recommendations included (Table 6) creating a specialized infection control unit for each institution and providing periodic infection control training. Participants also recommended expanding digital platform capabilities across universities and distributing ICT equipment to those in need. Improvements to the university website and training for both students and faculty members in e-learning and hybrid learning were also recommended to ensure unbroken academic sessions in future pandemics. This alongside providing adequate funding for internet bundles.

We are aware of several limitations of this study. These include that only a few universities with non-medical HCP educators were approached for this pilot project. Secondly, the sampling procedure was purposeful in achieving the study’s goals and objectives. Thirdly, students were purposefully excluded from this discussion so that their perspectives could not be examined in full. Despite these constraints, we feel that our findings are sound and that they will contribute to a future pandemic response strategy.

Conclusion

Covid-19 and the shift from traditional classrooms to online environments had an appreciable impact on the education of non-medical HCPs at the start of the pandemic. Several concerns and obstacles need to be addressed with the shifting of education
to an e-learning environment. Challenges included a lack of prior training in e-learning methodologies, lack of ICT equipment, and the cost of internet subscriptions. The pandemic also caused appreciable mental stress among both educators and students. These are starting to be addressed, indicating a path forward. The study’s findings also emphasize the need for HCP educational institutions to pay close attention to teacher-student issues and the influence of lockdown on academic careers.

The next stage of this research will be a more comprehensive study among non-medical HCPs to offer a complete picture for future guidance.

Conflict of Interest
The authors have no relevant conflicts of interest to declare

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Data Availability
Additional data is available on reasonable request to the corresponding authors.

References
1. Alsoufi A, Alsuyihili A, Msherghi A, Elhadi A, Atiyah H, Ashini A, Ashwieb A, Ghula M, Ben Hasan H, Abudabu0 S, Alameen H, Abokhdhir T, Anaiba M, Nagib T, Shuwayyah A, Benothman R, Arrefae G, Alkhwayildi A, Alhadi A, Zaid A, Elhadi M. Impact of the COVID-19 pandemic on medical education: Medical students’ knowledge, attitudes, and practices regarding electronic learning. PLoS One. 2020;15(11): e0242905. doi: 10.1371/journal.pone.0242905.
2. Kumar A, Singh R, Kaur J, Pandey S, Sharma V, Thakur L, Sati S, Mani S, Asthana S, Sharma TK, Chaudhuri S, Bhattacharyya S, Kumar N. Wuhan to World: The COVID-19 Pandemic. Front Cell Infect Microbiol. 2021; 11:596201. doi: 10.3389/fcimb.2021.596201.
3. World Health Organization. WHO Coronavirus (COVID-19) Dashboard. 2021. Available at https://covid19.who.int/ [Accessed on 13 May 2022]
4. Shah AUM, Safri SNA, Thевadas R, Noordin NK, Rahman AA, Sekawi Z, Ideris A, Sultan MTH. COVID-19 outbreak in Malaysia: Actions taken by the Malaysian government. Int J Infect Dis. 2020; 97:108-116. doi: 10.1016/j.ijid.2020.05.093
5. Verma BK, Verma M, Verma VK, Abdullah RB, Nath DC, Khan HTA, Verma A, Vishvakarma RK, Verma V. Global lockdown: An effective safeguard in responding to the threat of COVID-19. J Eval Clin Pract. 2020;26(6):1592-1598. doi: 10.1111/jep.13483.
6. Ayouni I, Maatoug J, Dhouib W, Zammit N, Fredj SB, Ghannam R, Ghannem H. Effective public health measures to mitigate the spread of COVID-19: a systematic review. BMC Public Health. 2021;21(1):1015. doi: 10.1186/s12889-021-11111-1.
7. Abubakar AR, Sani IH, Godman B, Kumar S, Islam S, Jahan I, Haque M. Systematic Review on the Therapeutic Options for COVID-19: Clinical Evidence of Drug Efficacy and Implications. Infect Drug Resist. 2020;13:4673-4695. doi: 10.2147/IDR.S289037.
8. Khandker SS, Godman B, Jawad MI, Meghla BA, Tisha TA, Khondoker MU, Haq MA, Charan J, Talukder AA, Azmuna N, Sharmin S, Jamiruddin MR, Haque M, Adnan N. A Systematic Review on COVID-19 Vaccine Strategies, Their Effectiveness, and Issues. Vaccines (Basel). 2021;9(12):1387. doi: 10.3390/vaccines9121387.
9. Ogunleye OO, Basu D, Mueller D, Sneddon J, Seaton RA, Yinka-Ogunleye AF, Wamboga J, Miljkoivič N, Mwitajc JC, Rwegerera GM, Massele A, Patrick O, Niba LL, Nsatikila M, Rashed WM, Hussein MA, Hegazy R, Amu AA, Bo ahen-Boaten BB, Matselula Z, Gwebu P, Chirigo B, Mukhabela N, Dlamini T, Sithole S, Malaza S, Dlamini S, Afriyie D, Asare GA, Ampomah SK, Sefah I, Oluka M, Guantai AN, Opanga SA, Sarele TV, Mafisa RK, Chikowe I, Khuluza F, Kibuule D, Kalemeera F, Mubita M, Fadare J, Sibomana L, Ramokgopa GM, Whyte C, Maimela T, Hugo J, Meyer JC, Schellack N, Rampamba EM, Visser A, Alfadl A, Malik EM, Malande OO, Kalungia AC, Mwila C, Zaranyika T, Chai bvua BV, Oiaru ID, Masuka N, Wale J, Hwenda L, Kamoga R, Hill R, Barbui C, Bochenek T, K urdi A, Campbell S, Martin AP, Phuong TNT, Thanh BN, Godman B. Response to the Novel Corona Virus (COVID-19) Pandemic Across Africa: Successes, Challenges, and Implications for the Future. Front Pharmacol. 2020;11:1205. doi: 10.3389/fphar.2020.01205.
10. Godman B, Haque M, Islam S, Iqbal S, Urmil UL, Kamal ZM, Shuvo SA, Rahman A, Kamal M, Haque M, Jahan I, Islam MZ, Hossain MM, Munzur-E-Murshid, Kumar S, Charan J, Bhatt R, Dutta S, Abhayananand JP, Sharma Y, Saleem Z, Phuong TNT, Kwon HY, Kurdi A, Wale J, Sefah I. Rapid Assessment of Price Instability and Paucity of Medicines and Protection for COVID-19 Across Asia: Findings and Public Health Implications for the Future. *Front Public Health*. 2020; 8:585832. doi: 10.3389/fpubh.2020.585832.

11. Ng Y, Li Z, Chua YX, Chaw WL, Zhao Z, Er B, Pung R, Chiew CJ, Lye DC, Heng D, Lee VJ. Evaluation of the Effectiveness of Surveillance and Containment Measures for the First 100 Patients with COVID-19 in Singapore - January 2-February 29, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(11):307-311. doi: 10.15585/mmwr.mm6911e1.

12. Alam ABMM, Azim Majumder MA, Haque M, Ashraf F, Khondoker MU, Marshkey SR, Wahab A, Siddiqui TH, Uddin A, Joarder T, Ahmed SMM, Deeba F, Nessa K, Rahman S, Jahan I, Islam Z, Adnan N, E-Murshid M, Islam S, Urmil UL, Yusuf A, Sarkar NC, Mallik TS, Raza AMS, Daud AKM, Razzaque MS. Disproportionate COVID-19 vaccine acceptance rate among healthcare professionals on the eve of nationwide vaccine distribution in Bangladesh. *Expert Rev Vaccines*. 2021;20(9):1167-1175. doi: 10.1080/14760584.2021.1951248.

13. Haque M, Islam S, Iqbal S, Urmil UL, Kamal ZM, Rahman A, Kamal M, Haque M, Jahan I, Islam Z, Hossain MM, Murshid ME, Sefah I, Kurdi A, Godman B. Availability and price changes of potential medicines and equipment for the prevention and treatment of COVID-19 among pharmacy and drug stores in Bangladesh; findings and implications. *Bang J Med Sci*. 2020;19(Special Issue on Covid19):S36-S50. doi: 10.3329/bjms.v19i0.48106

14. Mou TJ, Afroz KA, Haq MA, Jahan D, Ahmad R, Islam T, Chowdhury K, Kumar S, Irfan M, Islam MS, Islam MF, Adnan N, Haque M. The Effect of Socio-Demographic Factors in Health-Seeking Behaviors among Bangladeshi Residents during the First Wave of COVID-19. *Healthcare*. 2022;10(3):483. doi: 10.3390/healthcare10030483.

15. Haque M, Godman B. Key findings regarding COVID 19 in Bangladesh and wider and their implications. *Bangl J Med Sci*. 2021;20(5):199-205. doi: 10.3329/bjms.v20i5.55616

16. Chowdhury K, Haque M, Lutfor AB, Siddiqui TH, Ahmad R, Sultana I, Sharma P, Lugova H, Etando A, Godman B. Impact of the COVID-19 pandemic on dental and medical education in Bangladesh: a pilot study and the implications. *Bang J Med Sci*. 2022; 21(2): 444-454. doi: 10.3329/bjms.v21i2.58080

17. d’Orville H. COVID-19 causes unprecedented educational disruption: Is there a road towards a new normal? *Prospects (Paris)*. 2020;49(1-2):11-15. doi: 10.1007/s11125-020-09475-0.

18. Sahu P. Closure of Universities Due to Coronavirus Disease 2019 (COVID-19): Impact on Education and Mental Health of Students and Academic Staff. *Cureus*. 2020;12(4):e7541. doi: 10.7759/cureus.7541

19. Etando A, Amu AA, Haque M, Schellack N, Kurdi A, Alrasheedy AA, Timoney A, Mwita JC, Rwegerera GM, Patrick O, Niba LL, Boahen-Boaten BB, Tabi FB, Amu OY, Acolatse J, Incoom R, Sefah IA, Guantai AN, Opanga S, Chikowe I, Khuluza F, Kibuule D, Kalemeera F, Hango E, Lates J, Fadare J, Ogunleye OO, Saleem Z, Oosthuizen F, Cordier W, Matlala M, Meyer JC, Schellack G, Massele A, Malande OO, Kalungia AC, Sichone J, Banda SS, Zaranyika T, Campbell S, Godman B. Challenges and Innovations Brought about by the COVID-19 Pandemic Regarding Medical and Pharmacy Education Especially in Africa and Implications for the Future. *Healthcare (Basel)*. 2021;9(12):1722. doi: 10.3390/healthcare9121722.

20. Khailil R, Mansour AE, Fadda WA, Almsinid K, Aldamagh M, Al-Nafeesah A, Alkalifah A, Al-Wutayd O. The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: a qualitative study exploring medical students’ perspectives. *BMC Med Educ*. 2020;20(1):285. doi: 10.1186/s12909-020-02208-z.

21. Chowdhury K, Etando A, Shahwan M, Škrbić R, Jairoun AA, Haque M, Godman B. COVID-19 and the impact on the education of healthcare professionals across countries with a particular focus on developing countries. *Bang J Med Sci*. 2022;21(1):221-232. doi 10.3329/bjms.v21i2.58053

22. Ruiz JG, Mintzer MJ, Leipzig RM. The impact of E-learning in medical education. *Acad Med*. 2006;81(3):207-12. doi: 10.1097/00001888-200603000-00002

23. Amir LR, Tanti I, Maharani DA, Wimardhani YS, Julia V, Sulijaya B, Puspitawati R. Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia. *BMC Med Educ*. 2020; 20(1):392. doi: 10.1186/s12909-020-02312-0.

24. Gherhes V, Stoian CE, Fărcaș MA, Stanici M. E-Learning vs. Face-To-Face Learning: Analyzing Students’ Preferences and Behaviors. *Sustainability*. 2021; 13: 4381. doi: 10.3390/su13084381

25. Puljak L, Čivljak M, Haramina A, Mališa S, Čavić D, Klinec D, Aranz D, Mesarić J, Skitarelić N, Zoranić S, Majstorović D, Neuberg M, Mikišić Š, Ivanišević
K. Attitudes and concerns of undergraduate university health sciences students in Croatia regarding complete switch to e-learning during COVID-19 pandemic: a survey. *BMC Med Educ.* 2020;20(1):416. doi: 10.1186/s12909-020-02343-7

26. Gismalla MD-A, Mohamed MS, Ibrahim OSO, Elhassan MMA, Mohamed MN. Medical students’ perception towards E-learning during COVID-19 pandemic in a high burden developing country. *BMC Med Educ.* 2021;21(1):377. doi: 10.1186/s12909-021-02811-8

27. Alrasheedy AA, Abdul salim S, Farooqui M, Alsahali S, Godman B. Knowledge, Attitude and Practice About Coronavirus Disease (COVID-19) Pandemic and Its Psychological Impact on Students and Their Studies: A Cross-Sectional Study Among Pharmacy Students in Saudi Arabia. *Risk Manag Healthc Policy.* 2021;14:729-741. doi: 10.2147/RMHP.S292354.

28. Almendingen K, Morseth MS, Gjolstad E, Brevik A, Torris C. Student’s experiences with online teaching following COVID-19 lockdown: A mixed-methods explorative study. *PLoS One.* 2021;16(8):e0250378. doi: 10.1371/journal.pone.0250378

29. Zalat MM, Hamed MS, Bolbol SA. The experiences, challenges, and acceptance of e-learning as a tool for teaching during the COVID-19 pandemic among university medical staff. *PLoS One.* 2021;16(3):e0248758. doi: 10.1371/journal.pone.0248758.

30. Camargo CP, Tempeski PZ, Bussnardo FF, Martins MA, Gemperli R. Online learning and COVID-19: a meta-synthesis analysis. *Clinics (Sao Paulo).* 2020;75:e2286. doi: 10.6061/clinics/2020/e2286.

31. Gachanja F, Mwangi N, Gicheru W. E-learning in medical education during COVID-19 pandemic: experiences of a research course at Kenya Medical Training College. *BMC Med Educ.* 2021;21(1):612. doi: 10.1186/s12909-021-03050-7.

32. Stoehr F, Müller L, Brady A, Trilla A, Mähringer-Kunz A, Hahn F, Düber C, Becker N, Wörns MA, Chapiro J, Hinrichs JB, Akata D, Eillmann S, Huisman M, Koff D, Brinkmann S, Bamberg F, Zimmermann O, Traikova NI, Marquardt JU, Chang DH, Rengier F, Auer TA, Emrich T, Muehler F, Schmidberger H, Baelfler B, Dos Santos DP, Kloockner R. How COVID-19 kick-started online learning in medical education-The DigiMed study. *PLoS One.* 2021;16(9):e0257394. doi: 10.1371/journal.pone.0257394

33. Nusrat N, Rahman NAA, Godman B, D Rozario DT, Haque M. Antibiotic resistance and sensitivity pattern of Metallo-β-Lactamase Producing Gram-Negative Bacilli in ventilator-associated pneumonia in the intensive care unit of a public medical school hospital in Bangladesh. *Hosp Pract (1995).* 2020;48(3):128-136. doi: 10.1080/21548331.2020.1754687.

34. Nusrat N, Haque M, Chowdhury K, Adnan N, Lutfur AB, Karim E, Hassan M, Rabbany A, Begum D, Hasan MN, Sihan N, Zaman SU, Islam S, Schellack N, Gowere M, Kurdi A, Godman B. Pilot Study on the Current Management of Children with COVID-19 In Hospitals in Bangladesh: Findings and Implications. *Bang J Med Sci.* 2021; 20(5): 188–198. doi: 10.3329/bjm.v20i5.55615

35. Ahmed I, Rabbi MB, Sultana S. Antibiotic resistance in Bangladesh: A systematic review. *Int J Infect Dis.* 2019;80:54-61. doi: 10.1016/j.ijid.2018.12.017.

36. Fottrell E, Ahmed N, Shaha SK, Jennings H, Kuddus A, Morrison J, et al. Distribution of diabetes, hypertension, and non-communicable disease risk factors among adults in rural Bangladesh: a cross-sectional survey. *BMJ Glob Health.* 2018; 3(6):e000787. doi: 10.1136/bmjgh-2018-000787.

37. Chowdhury MZI, Rahman M, Akter T, Akhter T, Ahmed A, Shovon MA, Farhana Z, Chowdhury N, Turin TC. Hypertension prevalence and its trend in Bangladesh: evidence from a systematic review and meta-analysis. *Clin Hypertens.* 2020;26:10. doi: 10.1186/s40885-020-00143-1.

38. Haque M, Islam S, Kamal ZM, Akter F, Jahan I, Rahim MSA, Sultana N, Alam AM, Munzur-E-Murshid, Halim-Khan MA, Deeba F, Bakar MA, Nahar S, Mozaffer M, Urmi U, Saikat TR, Islam MZ, Haque M, Iqbal S, Hessain MM, Naher N, Allocati E, Godman B. Ongoing efforts to improve the management of patients with diabetes in Bangladesh and the implications. *Hosp Pract (1995).* 2021;49(4):266-272. doi: 10.1080/21548331.2021.1906083.

39. Chan JCN, Lim LL, Wareham NJ, Shaw JE, Orchard TJ, Zhang P, Lau ESH, Eliasson B, Kong APS, Ezzati M, Aguilar-Salinas CA, McGill M, Levitt NS, Ning G, So WY, Adams J, Bracco P, Forouhi NG, Gregory GA, Guo J, Hua X, Klatman EL, Magliano DJ, Ng BP, Ogilvie D, Panter J, Pavkov M, Shao H, Unwin N, White M, Wou C, Ma RCW, Schmidt MI, Ramachandran A, Seino DT, Haque M, Islam S, Mwita J, do Nascimento RCRM, Dias Godói AP, Cordeiro EB, Alves MN, Ogunleye OO, Olalekan A, Markovic-Pekovic V, Meyer JC, Alfadl A, Phuong TNT, Kalungia AC, Campbell S, Pisana A, Wale J, Seaton RA. Strategies to Improve
Antimicrobial Utilization with a Special Focus on Developing Countries. *Life (Basel).* 2021;11(6):528. doi: 10.3390/life11060528.

41. Haque M, Godman B. Potential Strategies to Improve Antimicrobial Utilisation in Hospitals in Bangladesh Building on Experiences Across Developing Countries. *Bang J Med Sci.* 2021; 20(3):469-477. doi: 10.3329/bjms.v20i3.52787

42. Akter F, Haque M, Akter S, Uddin G, Chy N, Kalemeera F, Kurdi A, Chowdhury K, Godman B. Assessing the management of patients with type 2 diabetes in Bangladesh during pre-and post-COVID-19 era and the implications: A pilot study. *J Appl Pharm Sci.* 2022; 12(05):088-097. doi: 10.7324/JAPS.2022.120506.

43. Sharma P, Chowdhury K, Kumar S, Bhatt R, Hirani T, Duseja S, Haque M, Lutfor AB, Etando A, Škribić R, Shahwan M, Jairoun AA, Godman B. A Pilot Study Regarding the Consequence of the COVID-19 Pandemic on Healthcare Education in India and The Implications. *Adv Hum Biol.* 2022;12(2):180-189. doi: 10.4103/aihb.aihb_34_22

44. Ramanadhan S, Revette AC, Lee RM, Aveling EL. Pragmatic approaches to analyzing qualitative data for implementation science: an introduction. *Implement Sci Commun.* 2021;2(1):70. doi: 10.1186/s43058-021-00174-1.

45. Nowell L. Pragmatism and integrated knowledge translation: exploring the compatibilities and tensions. *Nurs Open.* 2015;2(3):141-148. doi: 10.1002/nop.2.30

46. Kelly LM, Cordeiro M. Three principles of pragmatism for research on organizational processes. *Methodological Innovations.* 2020;13(2):2059799120937242. doi:10.1177/2059799120937242

47. Gantman A, Gomila R, Martinez JE, Matias JN, Paluck EL, Starck J, Wu S, Yaffe N. A pragmatist philosophy of psychological science and its implications for replication. *Behav Brain Sci.* 2018;41:e127. doi: 10.1017/S0140525X18000626.

48. Starke G, De Clercq E, Elger BS. Towards a pragmatist dealing with algorithmic bias in medical machine learning. *Med Health Care Philos.* 2021;24(3):341-349. doi: 10.1007/s11019-021-10008-5.

49. Candiotto L, Dreon R. Affective Scaffolding as Habits: A Pragmatist Approach. *Front Psychol.* 2021;12:629046. doi: 10.3389/fpsyg.2021.629046.

50. Kaushik V, Walsh CA. Pragmatism as a Research Paradigm and Its Implications for Social Work Research. *Soc Sci.* 2019; 8(9):255. doi: 10.3390/soscii8090255

51. Campbell S, Greenwood M, Prior S, Shearer T, Wallum K, Young S, et al. Purposive sampling: complex or simple? Research case examples. *J Res Nurs.* 2020;25(8):652-61.
61. Blackman SNJ. The impact of Covid-19 on education equity: A view from Barbados and Jamaica. *Prospects (Paris).* 2021;1-15. doi: 10.1007/s11125-021-09568-4.

62. Al-Balas M, Al-Balas HI, Jaber HM, Obeidat K, Al-Balas H, Aborajooh EA, Al-Taheer R, Al-Balas B. Distance learning in clinical medical education amid COVID-19 pandemic in Jordan: current situation, challenges, and perspectives. *BMC Med Educ.* 2020;20(1):341. doi: 10.1186/s12909-020-02257-4.

63. Tadesse S, Muluye W. The Impact of COVID-19 Pandemic on Education System in Developing Countries: A Review. *Open J Soc Sci.* 2020; 8: 159–170. doi: 10.4236/jss.2020.810011

64. Yousuf R, Salam A. Teaching medical education during the era of COVID-19 pandemic: challenges and probable solutions. *Bang J Med Sci, Special Issue on COVID-19.* 2021; 20(5): S3 - S6. doi:10.3329/bjms.v20i3.S55394.

65. Almahia MA, Al-Khasawneh A, Alhunibat A. Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. *Educ Inf Technol.* 2020; 25: 5261–5280. doi: 10.1007/ s10639-020-10219-y.

66. Ebohon O, Obienu AC, Irabor F, Amadin FI, Omorogbie ES. Evaluating the impact of COVID-19 pandemic lockdown on education in Nigeria: Insights from teachers and students on virtual/online learning. *Bull Natl Res Cent.* 2021;45(1):76. doi: 10.1186/s42269-021-00538-6.

67. Chowdhury K, Haque M, Etando A, Kumar S, Lugova H, Shahwan M, Škrbic R, Jairoun AA, Brian Godman B. The global impact of the COVID-19 pandemic on the education of healthcare professionals, especially in low- and middle-income countries. *Adv Hum Biol.* 2022;12(2):87-92. doi: 10.4103/ahb.ahb.60_22

68. Soliman M, Aldhaferi S, Neel K. Experience from a medical college in Saudi Arabia on undergraduate curriculum management and delivery during COVID-19 pandemic. *J Nat Sci Med.* 2021;4(2):85-9. doi: 10.4103/ jnsm.jnsm_46_20

69. Nasir MKM. The Influence of Social Presence on Students’ Satisfaction toward Online Course. *Open Praxis.* 2020; 12 (4): 485-493. doi: 10.5944/openpraxis.12.4.1141

70. Ela MZ, Shohel TA, Shovo TE, Khan L, Jahan N, Hossain MT, Islam MN. Prolonged lockdown and academic uncertainties in Bangladesh: A qualitative investigation during the COVID-19 pandemic. *Heliyon.* 2021;7(2):e06263. doi: 10.1016/j.heliyon.2021.e06263.

71. Piya FL, Amin S, Das A, Kabir MA. Impacts of COVID-19 on the Education, Life, and Mental Health of Students in Bangladesh. *Int J Environ Res Public Health.* 2022;19(2):785. doi: 10.3390/ijerph19020785.

72. Amit S, Barua L, Kafy AA. A perception-based study to explore COVID-19 pandemic stress and its factors in Bangladesh. *Diabetes Metab Syndr.* 2021; 15(4): 102129. doi: 10.1016/j.dsx.2021.05.002.

73. Kapasia N, Paul P, Roy A, Saha J, Zaveri A, Mallick R, Barman B, Das P, Chouhan P. Impact of lockdown on learning status of undergraduate and postgraduate students during COVID-19 pandemic in West Bengal, India. *Child Youth Serv Rev.* 2020;116:105194. doi: 10.1016/j.childyouth.2020.105194.

74. Islam MA, Barma SD, Raihan H, Khan MNA, Hossain MT. Depression and anxiety among university students during the COVID-19 pandemic in Bangladesh: A web-based cross-sectional survey. *PLoS One.* 2020;15(8):e0238162. doi: 10.1371/journal.pone.0238162.

75. Saraswathi I, Saikarthik J, Senthil Kumar K, Madhan Srinivasan K, Ardhanaari M, Gunapiyra R. Impact of COVID-19 outbreak on the mental health status of undergraduate medical students in a COVID-19 treating medical college: a prospective longitudinal study. *PeerJ.* 2020;8:e10164. doi: 10.7717/peerj.10164.

76. Padhi KS, Balmuchu G, Acharya PS, Singh SR, Joseph T. The Perspectives of Educators and Learners on E-Learning: A Cross-Sectional Descriptive Study in a Medical School. *Adv Med Educ Pract.* 2021;12:1059-1066. doi: 10.2147/AMEP.S326147.

77. Oishee MJ, Ali T, Jahan N, Khandker SS, Haq MA, Khondoker MU, Sil BK, Lugova H, Krishnapillai A, Abubakar AR, Kumar S, Haque M, Jamiruddin MR, Adnan N. COVID-19 Pandemic: Review of Contemporary and Forthcoming Detection Tools. *Infect Drug Resist.* 2021;14:1049-1082. doi: 10.2147/IDR. S289629.