The Global Impact of the COVID-19 Pandemic on the Education of Healthcare Professionals, Especially in Low- and Middle-Income Countries

The COVID-19 disaster has appreciably increased morbidity and mortality, as well as the delivery of health care, across countries exacerbated by the contagious nature of the virus.[1-4] Numerous public health measures were instigated across countries at the start of the pandemic to try and limit its spread without effective medicines and vaccines.[5,6] Introduced measures included lockdown activities, social distancing instructions, quarantining measures, wearing of personal protective equipment (PPE), handwashing and sanitisers, as well as the closure of borders.[5-8] Instigated measures also included the closure of universities, appreciably affecting the education of health-care professionals (HCPs), including physicians and pharmacists, across countries.[9-11] The extent of lockdown and other activities instigated during the early stages of the virus varied appreciably across countries, leading to differences in observed morbidity and mortality rates.[12-15] For instance, comprehensive measures introduced early among several Asian countries, including Korea, Malaysia, Taiwan and Vietnam, as well as among several African countries, including Ghana, Malawi and Namibia, limited the number of deaths certainly when compared with Western European countries, including Italy, Spain and the UK.[13-17]

As a result of the pandemic, traditional face-to-face teaching–learning instructional methods for HCP students could no longer continue cognisant of the safety of both educators and students.[11,18,19] This caused concern, certainly among faculty staff and students in several countries, since conventionally medical, dental and allied health professional education had been through campus-based educational activities.[20] Typically, the teaching of HCPs comprised face-to-face instructional sessions combined with practical sessions, observations and by hand activity through experienced clinicians or other allied HCPs.[19,21-26] However, teaching approaches were beginning to change before the pandemic, especially in higher-income countries, with the instigation of blended approaches, including e-learning, with studies showing potentially improved learning through such approaches.[27-29] However, there were concerns with the extra burden for both educators and students and available facilities.[30] In addition, other than campus-based formal settings such as lecture halls or in-hospital or ambulatory care health-care settings, HCP students often learn when sitting and chatting together as well as through teacher–student and peer interactions when in health-care settings. This includes taking part in social activities, all of which are also forms of face-to-face learning.[31] Consequently, the closure of universities was highly problematic, especially for medical, dental and allied health professional education with practical and hands-on teaching of cases.[32-34]

One of the top priorities for any national government should be developing and ensuring trained HCPs to manage diseases within their populations.[35] This is especially important in low- and middle-income countries (LMICs) with their increasing burden of infectious diseases along with growing rates of antimicrobial resistance (AMR), with its subsequent impact on morbidity, mortality and costs.[36-39] AMR rates are expected to grow with high rates of antimicrobial prescribing for patients with COVID-19 despite limited numbers of bacterial or fungal co-infections unless addressed.[40-45] Potential activities to improve antibiotic prescribing and dispensing include making sure all HCPs are fully conversant regarding antibiotics and antimicrobial stewardship programmes, which is not always the case.[46-50] Encouragingly, Mohamad *et al.* showed low rates of antimicrobial use among patients with COVID-19 in the community in Malaysia, providing direction to others.[51]

Alongside concerns with inappropriate prescribing of antimicrobials and the resultant impact, there is continued growth in the prevalence of non-communicable diseases (NCDs), including cardiovascular diseases and diabetes, across LMICs, which, if not optimally treated, will increase complication rates and associated morbidity, mortality and costs.[52-55] Issues of complications and their costs are especially important in LMICs where there can be high co-payment levels, as seen in many African and Asian countries, which can potentially be catastrophic for patients and their families.[56-61] Co-payment expenditures increased at least twice as much between 2000 and 2017 in LMICs versus high-income countries, further exacerbating the situation.[62] Launching national programmes to improve the prevention and management of NCDs can reduce such expenditures. Coupled with this, minimising the number

of medicines prescribed as well as physicians preferentially prescribing lower-cost multiple sourced medicines; however, this requires fully trained HCPs.[63-65]

Fully trained HCPs are also necessary to address any misinformation regarding possible treatments for patients with COVID-19 and vaccines.[66] This happened with hydroxychloroquine following early endorsement with limited numbers of patients in the initial studies, which resulted in increased mortality and costs.[14,67-70] There has also been considerable misinformation regarding vaccines for COVID-19 impacting on their uptake.[71-74] Community pharmacists, in particular, can play a key role in providing symptomatic relief, discussing protective measures, including PPE, helping with vaccinations and dispelling myths.[15,75-77]

The closure of universities resulted in a rapid re-think among educators regarding the teaching of HCPs especially among LMICs.[78] E-learning approaches, including live video-based classes, came to the forefront of teaching, enabling HCP students to complete their training despite university closures.[79-88] Online learning is defined as computer-generated teaching–learning instructional methods through the Internet.[84] Several teaching–learning approaches subsequently evolved during the pandemic in addition to video-based classes as both students and lecturers adapted to this approach,[81,82,88,89] which are here to stay. E-learning approaches that have evolved during the pandemic include virtual lectures, lecture capture technologies for viewing lectures in home environments, teleteaching via Microsoft Teams™ as well as the use of telemedicine for clinical teaching.[90-94] Encouragingly, the effectiveness of e-learning approaches has not been significantly different from traditional learning approaches.[95,96] Having said this, appreciable barriers and concerns towards e-learning still exist. Concerns include the availability of suitable devices among students, regular access and affordability of the Internet and quiet rooms for learning.[11,96,97] Potential barriers for both students and educators also include ensuring that e-assessments are at least of equal standard to traditional methods and potentially more rigorous.[98,99] Technological improvements can potentially be implemented to improve student and teacher interactions during teaching–learning alongside additional funding for disadvantaged students to address concerns.[11,96,100,101]

Alongside this, there are also issues and concerns regarding changes in the mental health of both students and staff caused by the closure of universities and associated isolation. This could potentially impact on the training and knowledge of HCP students, exacerbated by reduced hands-on experiences leading to a number of issues including future job security.[96,102-105]

Higher-income countries appeared better prepared for university closure and the implications for teaching HCP students than lower-income countries; however, this was not always the case. For instance, there had been considerable investment in university education among high-income Arab countries before the pandemic. This included Saudi Arabia, where there had been appreciable investment in IT equipment to enhance blending learning before the pandemic.[106] As a result, there appeared to be a relatively smooth transition from blended approaches towards predominantly e-learning approaches using BlackBoard™, Backboard Collaborate® and Zoom® platforms for teaching, including interactive sessions and examinations, at the start of the pandemic.[106-109] There was a similar situation in the United Arab Emirates (UAE), where most universities already had e-learning management systems at the start of the pandemic.[110] Early challenges were addressed by flexible approaches to teaching and the authorities working with local telecommunication companies to provide free access to online learning platforms as well as expand the bandwidth of the Internet, which resulted in high levels of trust and confidence between students and educators.[109-112] Initiatives and experiences were similar among several universities across UAE.[110,111]

This contrasts with several LMICs where students and educators struggled at the start of the pandemic with critical issues. Key issues included funding for devices and Internet bundles and a lack of familiarity with e-learning approaches.[9,11,84,88,113] This was particularly the case across Africa, although the situation improved with increased support for both students and educators.[11] There were similar concerns in Bangladesh, which are also being addressed,[114] as well as with a number of Central and Eastern European countries. These included Bulgaria, the Czech Republic, Poland and some Universities in Romania at the start of the pandemic.[115-119] This is now changing with increasing familiarity and good support from educators, mirroring the situation in Latvia and Slovenia.[117-121] Students and educators at the top universities in the Republic of Srpska (Bosnia and Herzegovina) were also generally well equipped with the necessary devices to fully implement e-learning approaches at the start of the pandemic alongside affordable Internet facilities, with students usually ready to accept e-learning as a new educational model.[110] Overall, there was a comprehensive approach at the University of Banja Luka in the Republic of Srpska at the start of the pandemic to rapidly instigate e-learning approaches, which were well received by the students.[110]

A recent pilot study in India also identified a number of issues and challenges for both HCP students and educators at the start of the pandemic.[122] These included a lack of devices and equipment alongside a lack of familiarity with e-learning approaches at the start of the pandemic among some students, combined with issues of Internet connectivity and affordability of Internet bundles.[122] This is starting to be addressed, with the findings of the pilot study in India being taken forward to help further guide university personnel and authorities in future pandemics. Similar challenges and issues have also been seen in Malaysia, with this research also being taken forward to further guide approaches to enhance HCP education in Malaysia and wider during this and future pandemics.

In conclusion, innovations with e-learning approaches will continue with blending learning here to stay. This is being enhanced by universities and governments seeking to address the challenges, including available devices and Internet bundles. Alongside this, there will be continuing research to improve online learning approaches and experiences as well as address recognised difficulties relating to practical and clinical clerkship and rotations together with the integrity of examinations. Alongside this, there will be ongoing research to help mitigate the psychological and emotional health consequences of COVID-19 and lockdown measures among academic staff and HCP students, which can be considerable.[123-126] Hopefully, these combined activities will play a critical role among medical doctors, dentists and other HCPs in handling progressively complicated patients in the coming years. We will continue to monitor the state of affairs and suggest future initiatives where pertinent.

Kona Chowdhury[1], Mainul Haque[2], Ayukafangha Etando[3], Santosh Kumar[4], Halyna Lugova[5], Moyad Shahwan[6,7], Ranko Škrbic[8], Ammar Abdulrahman Jairoun[9,10], Brian Godman[6,11,12]

[1]Department of Paediatrics, Gonoshasthaya Samaj Vittik Medical College and Hospital, Dhaka, Bangladesh, [2]Unit of Pharmacology, Faculty of Medicine and Defence Health, Universiti Pertahanan Nasional Malaysia (National Defence University of Malaysia), [3]Department of Medical Laboratory Sciences, Faculty of Health Sciences, Eswatini Medical Christian University, Mbabane, Eswatini, [4]Department of Periodontology and Implantology, Karnavati University, Gandhinagar, Gujarat, India, [5]Humanitarian Assistance in Disaster Relief Centre, Community Medicine Unit, Faculty of Medicine and Defence Health Research Fellow, National Defence University of Malaysia, Kuala Lumpur, [6]College of Pharmacy and Health Science, Ajman University, [7]Center of Medical and Bio-allied Health Sciences Research, Ajman University, Ajman, United Arab Emirates, [8]Department of Pharmacology, Toxicology and Clinical Pharmacology, Faculty of Medicine, University of Banja Luka, Banja Luka, Republic of Srpska, Bosnia and Herzegovina, [9]Health and Safety Department, Dubai Municipality, Dubai, United Arab Emirates, [10]Discipline of Social and Administrative Pharmacy, School of Pharmaceutical Sciences, Universiti Sains Malaysia, Gelugor, Pulau Pinang, Malaysia, [11]Department of Pharmacoepidemiology, Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow, UK, [12]Division of Public Health Pharmacy and Management, School of Pharmacy, Sefako Makgatho Health Sciences University, Pretoria, South Africa

Address for correspondence:
Dr. Mainul Haque,
Unit of Pharmacology, Faculty of Medicine and Defence Health, Universiti Pertahanan Nasional Malaysia (National Defence University of Malaysia), Kem Perdana Sungai, Besi 57000, Kuala Lumpur, Malaysia.
E-mail: runurono@gmail.com
Prof. Brian Godman,
Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow, G4 0RE, United Kingdom.
E-mail: Brian.Godman@strath.ac.uk

Submitted: 25-Mar-2022 **Revised:** 03-Apr-2022
Accepted: 05-Apr-2022 **Published:** 29-Apr-2022

References

1. WHO. WHO Coronavirus (COVID-19) Dashboard; 2022. Available from: https://covid19.who.int/. [Last accessed on 2022 Mar 23].
2. Fernandez R, Lord H, Halcomb E, Moxham L, Middleton R, Alananzeh I, *et al.* Implications for COVID-19: A systematic review of nurses' experiences of working in acute care hospital settings during a respiratory pandemic. Int J Nurs Stud 2020;111:103637.
3. Shadmi E, Chen Y, Dourado I, Faran-Perach I, Furler J, Hangoma P, *et al.* Health equity and COVID-19: Global perspectives. Int J Equity Health 2020;19:104.
4. Mohapatra RK, Pintilie L, Kandi V, Sarangi AK, Das D, Sahu R, *et al.* The recent challenges of highly contagious COVID-19, causing respiratory infections: Symptoms, diagnosis, transmission, possible vaccines, animal models, and immunotherapy. Chem Biol Drug Des 2020;96:1187-208.
5. Nussbaumer-Streit B, Mayr V, Dobrescu AI, Chapman A, Persad E, Klerings I, *et al.* Quarantine alone or in combination with other public health measures to control COVID-19: A rapid review. Cochrane Database Syst Rev 2020;9:Cd013574.
6. Ayouni I, Maatoug J, Dhouib W, Zammit N, Fredj SB, Ghammam R, *et al.* Effective public health measures to mitigate the spread of COVID-19: A systematic review. BMC Public Health 2021;21:1015.
7. Girum T, Lentiro K, Geremew M, Migora B, Shewamare S, Shimbre MS. Optimal strategies for COVID-19 prevention from global evidence achieved through social distancing, stay at home, travel restriction and lockdown: A systematic review. Arch Public Health 2021;79:150.
8. Talic S, Shah S, Wild H, Gasevic D, Maharaj A, Ademi Z, *et al.* Effectiveness of public health measures in reducing the incidence of COVID-19, SARS-CoV-2 transmission, and COVID-19 mortality: Systematic review and meta-analysis. BMJ 2021;375:e068302.
9. Alsoufi A, Alsuyihili A, Msherghi A, Elhadi A, Atiyah H, Ashini A, *et al.* Impact of the COVID-19 pandemic on medical education: Medical students' knowledge, attitudes, and practices regarding electronic learning. PLoS One 2020;15:e0242905.
10. Triemstra JD, Haas MR, Bhavsar-Burke I, Gottlieb-Smith R, Wolff M, Shelgikar AV, *et al.* Impact of the COVID-19 pandemic on the clinical learning environment: Addressing identified gaps and seizing opportunities. Acad Med 2021;96:1276-81.
11. Etando A, Amu AA, Haque M, Schellack N, Kurdi A, Alrasheedy AA, *et al.* 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;9:1722.
12. Haque M, Kumar S, Charan J, Bhatt R, Islam S, Dutta S, *et al.* Utilisation, availability and price changes of medicines and protection equipment for COVID-19 among selected regions in India: Findings and implications. Front Pharmacol 2020;11:582154.
13. Ogunleye OO, Basu D, Mueller D, Sneddon J, Seaton RA, Yinka-Ogunleye AF, *et al.* Response to the novel corona virus (COVID-19) pandemic across Africa: Successes, challenges, and implications for the future. Front Pharmacol 2020;11:1205.
14. Godman B, Haque M, Islam S, Iqbal S, Urmi UL, Kamal ZM, *et al.* 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.
15. Kibuule D, Nambahu L, Sefah IA, Kurdi A, Phuong TN, Kwon HY, *et al*. Activities in Namibia to limit the prevalence and mortality from COVID-19 including community pharmacy activities and the implications. Sch Acad J Pharm 2021;5:82-92.
16. Afriyie DK, Asare GA, Amponsah SK, Godman B. COVID-19 pandemic in resource-poor countries: Challenges, experiences and opportunities in Ghana. J Infect Dev Ctries 2020;14:838-43.
17. Shah AU, Safri SN, Thevadas R, Noordin NK, Rahman AA, Sekawi Z, *et al.* COVID-19 outbreak in Malaysia: Actions taken by the Malaysian government. Int J Infect Dis 2020;97:108-16.
18. Amir LR, Tanti I, Maharani DA, Wimardhani YS, Julia V, Sulijaya B, *et al.* Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia. BMC Med Educ 2020;20:392.
19. Khalil R, Mansour AE, Fadda WA, Almisnid K, Aldamegh M, Al-Nafeesah A, *et al.* 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;20:285.
20. Jacobsen HE. A comparison of on-campus first year undergraduate nursing students' experiences with face-to-face and on-line discussions. Nurse Educ Today 2006;26:494-500.
21. Yu TC, Wilson NC, Singh PP, Lemanu DP, Hawken SJ, Hill AG.

Medical students-as-teachers: A systematic review of peer-assisted teaching during medical school. Adv Med Educ Pract 2011;2:157-72.
22. Brierley C, Ellis L, Reid ER. Peer-assisted learning in medical education: A systematic review and meta-analysis. Med Educ 2022;56:365-73.
23. Douglas AH, Acharya SP, Allery LA. Communication skills learning through role models in Nepal; what are medical students really learning? A qualitative study. BMC Med Educ 2021;21:625.
24. Bosch J, Maaz A, Hitzblech T, Holzhausen Y, Peters H. Medical students' preparedness for professional activities in early clerkships. BMC Med Educ 2017;17:140.
25. Kalén S, Lachmann H, Varttinen M, Möller R, Bexelius TS, Ponzer S. Medical students' experiences of their own professional development during three clinical terms: A prospective follow-up study. BMC Med Educ 2017;17:47.
26. Kalén S, Ponzer S, Seeberger A, Kiessling A, Silén C. Longitudinal mentorship to support the development of medical students' future professional role: A qualitative study. BMC Med Educ 2015;15:97.
27. Liu Q, Peng W, Zhang F, Hu R, Li Y, Yan W. The effectiveness of blended learning in health professions: Systematic review and meta-analysis. J Med Internet Res 2016;18:e2.
28. Vallée A, Blacher J, Cariou A, Sorbets E. Blended learning compared to traditional learning in medical education: Systematic review and meta-analysis. J Med Internet Res 2020;22:e16504.
29. Atwa H, Shehata MH, Al-Ansari A, Kumar A, Jaradat A, Ahmed J, *et al.* Online, face-to-face, or blended learning? Faculty and medical students' perceptions during the COVID-19 pandemic: A mixed-method study. Front Med (Lausanne) 2022;9:791352.
30. Salim H, Lee PY, Ghazali SS, Ching SM, Ali H, Shamsuddin NH, *et al.* Perceptions toward a pilot project on blended learning in Malaysian family medicine postgraduate training: A qualitative study. BMC Med Educ 2018;18:206.
31. Fleming-Nouri A, Crocombe D, Sammaraiee Y. Twelve tips on setting up and running a peer-led medical education society. Med Teach 2016;38:1199-203.
32. Coto J, Restrepo A, Cejas I, Prentiss S. The impact of COVID-19 on allied health professions. PLoS One 2020;15:e0241328.
33. Farrokhi F, Mohebbi SZ, Farrokhi F, Khami MR. Impact of COVID-19 on dental education – A scoping review. BMC Med Educ 2021;21:587.
34. Gupta MM, Jankie S, Pancholi SS, Talukdar D, Sahu PK, Sa B. Asynchronous environment assessment: A pertinent option for medical and allied health profession education during the COVID-19 pandemic. Educ Sci 2020;10:352.
35. Terwindt F, Rajan D, Soucat A. Chapter 4. Priority Setting for National Health Policies, Strategies, and Plans; 2016. Available from: https://apps.who.int/iris/bitstream/handle/10665/250221/9789241549745-chapter 4-eng.pdf?sequence=36. [Last accessed on 2022 Mar 22].
36. Laxminarayan R, Van Boeckel T, Frost I, Kariuki S, Khan EA, Limmathurotsakul D, *et al.* The Lancet Infectious Diseases Commission on antimicrobial resistance: 6 years later. Lancet Infect Dis 2020;20:e51-60.
37. Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. Lancet 2022;399:629-55.
38. Godman B, Egwuenu A, Haque M, Malande OO, Schellack N, Kumar S, *et al.* Strategies to improve antimicrobial utilization with a special focus on developing countries. Life (Basel) 2021;11:528.
39. Hofer U. The cost of antimicrobial resistance. Nat Rev Microbiol 2019;17:3.
40. Langford BJ, So M, Raybardhan S, Leung V, Soucy JR, Westwood D, *et al.* Antibiotic prescribing in patients with COVID-19: Rapid review and meta-analysis. Clin Microbiol Infect 2021;27:520-31.
41. Langford BJ, So M, Raybardhan S, Leung V, Westwood D, MacFadden DR, *et al.* Bacterial co-infection and secondary infection in patients with COVID-19: A living rapid review and meta-analysis. Clin Microbiol Infect 2020;26:1622-9.
42. Chowdhury K, Haque M, Nusrat N, Adnan N, Islam S, Lutfor AB, *et al.* Management of children admitted to hospitals across bangladesh with suspected or confirmed COVID-19 and the implications for the future: A nationwide cross-sectional study. Antibiotics (Basel) 2022;11:105.
43. Kumar S, Haque M, Shetty A, Acharya J, Kumar M, Sinha V, *et al.* Current management of children with COVID-19 in hospitals in India; Pilot study and findings. Adv Hum Biol 2022;12:16-21.
44. Lai CC, Chen SY, Ko WC, Hsueh PR. Increased antimicrobial resistance during the COVID-19 pandemic. Int J Antimicrob Agents 2021;57:106324.
45. Knight GM, Glover RE, McQuaid CF, Olaru ID, Gallandat K, Leclerc QJ, *et al.* Antimicrobial resistance and COVID-19: Intersections and implications. Elife 2021;10:e64139.
46. Haque M, Rahman NAA, McKimm J, Binti Abdullah SL, Islam MZ, Zulkifli Z, *et al.* A cross-sectional study evaluating the knowledge and beliefs about, and the use of antibiotics amongst Malaysian university students. Expert Rev Anti Infect Ther 2019;17:275-84.
47. Higuita-Gutiérrez LF, Roncancio Villamil GE, Jiménez Quiceno JN. Knowledge, attitude, and practice regarding antibiotic use and resistance among medical students in Colombia: A cross-sectional descriptive study. BMC Public Health 2020;20:1861.
48. Majumder MA, Singh K, Hilaire MG, Rahman S, Sa B, Haque M. Tackling antimicrobial resistance by promoting antimicrobial stewardship in medical and allied health professional curricula. Expert Rev Anti Infect Ther 2020;18:1245-58.
49. Tiong TW, Chua SS. Knowledge and attitude of university students on antibiotics: A cross-sectional study in Malaysia. Drug Healthc Patient Saf 2020;12:135-44.
50. Hoxha I, Malaj A, Kraja B, Bino S, Oluka M, Marković-Peković V, *et al.* Are pharmacists' good knowledge and awareness on antibiotics taken for granted? The situation in Albania and future implications across countries. J Glob Antimicrob Resist 2018;13:240-5.
51. Mohamad IN, Wong CK, Chew CC, Leong EL, Lee BH, Moh CK, *et al.* The landscape of antibiotic usage among COVID-19 patients in the early phase of pandemic: A Malaysian national perspective. J Pharm Policy Pract 2022;15:4.
52. Chan JC, Lim LL, Wareham NJ, Shaw JE, Orchard TJ, Zhang P, *et al.* The Lancet Commission on diabetes: Using data to transform diabetes care and patient lives. Lancet 2021;396:2019-82.
53. Rosengren A, Smyth A, Rangarajan S, Ramasundarahettige C, Bangdiwala SI, AlHabib KF, *et al.* Socioeconomic status and risk of cardiovascular disease in 20 low-income, middle-income, and high-income countries: The Prospective Urban Rural Epidemiologic (PURE) study. Lancet Glob Health 2019;7:e748-60.
54. Bommer C, Sagalova V, Heesemann E, Manne-Goehler J, Atun R, Bärnighausen T, *et al.* Global economic burden of diabetes in adults: Projections from 2015 to 2030. Diabetes Care 2018;41:963-70.
55. Gheorghe A, Griffiths U, Murphy A, Legido-Quigley H, Lamptey P, Perel P. The economic burden of cardiovascular disease and hypertension in low- and middle-income countries: A systematic review. BMC Public Health 2018;18:975.
56. Rahman MM, Zhang C, Swe KT, Rahman MS, Islam MR, Kamrujjaman M, *et al.* Disease-specific out-of-pocket healthcare expenditure in urban Bangladesh: A Bayesian analysis. PLoS One 2020;15:e0227565.
57. Swe KT, Rahman MM, Rahman MS, Saito E, Abe SK, Gilmour S, *et al.* Cost and economic burden of illness over 15 years in Nepal: A comparative analysis. PLoS One 2018;13:e0194564.
58. Essue BM, Laba M, Knaul F, Chu A, Minh HV, Nguyen TK, *et al.* Economic burden of chronic ill health and injuries for households in low- and middle-income countries. In: Jamison DT, Gelband H, Horton S, Jha P, Laxminarayan R, Mock CN, *et al.*, editors. Disease Control Priorities: Improving Health and Reducing Poverty. Washington (DC): The International Bank for Reconstruction and Development/The World Bank© 2022 International Bank for Reconstruction and Development/The World Bank; 2017.
59. Borde MT, Kabthymer RH, Shaka MF, Abate SM. The burden of household out-of-pocket healthcare expenditures in Ethiopia: A systematic review and meta-analysis. Int J Equity Health 2022;21:14.
60. Haque M, Abubakar AR, Ogunleye OO, Sani IH, Sefah I, Kurdi A, *et al.* Changes in availability, utilization, and prices of medicines and protection equipment for COVID-19 in an Urban population of northern Nigeria. J Res Pharm Pract 2021;10:17-22.
61. Aregbeshola BS, Khan SM. Out-of-pocket payments, catastrophic health expenditure and poverty among households in Nigeria 2010. Int J

Health Policy Manag 2018;7:798-806.
62. Jalali FS, Bikineh P, Delavari S. Strategies for reducing out of pocket payments in the health system: A scoping review. Cost Eff Resour Alloc 2021;19:47.
63. Kastor A, Mohanty SK. Disease-specific out-of-pocket and catastrophic health expenditure on hospitalization in India: Do Indian households face distress health financing? PLoS One 2018;13:e0196106.
64. Miljeteig I, Defaye FB, Wakim P, Desalegn DN, Berhane Y, Norheim OF, *et al.* Financial risk protection at the bedside: How Ethiopian physicians try to minimize out-of-pocket health expenditures. PLoS One 2019;14:e0212129.
65. Kavosi Z, Lankarani KB, Dehnavieh R, Ghorbanian A. Influential factors of out of pocket payments for health care in Iran: A foresight approach using the cross impact analysis. J Pak Med Assoc 2020;70:1918-26.
66. Godman BB. Combating COVID-19: Lessons learnt particularly among developing countries and the implications. Bangladesh J Med Sci 2020;19:103-8.
67. Ferner RE, Aronson JK. Chloroquine and hydroxychloroquine in COVID-19. BMJ 2020;369:m1432.
68. Abena PM, Decloedt EH, Bottieau E, Suleman F, Adejumo P, Sam-Agudu NA, *et al.* Chloroquine and hydroxychloroquine for the prevention or treatment of COVID-19 in Africa: Caution for inappropriate off-label use in healthcare settings. Am J Trop Med Hyg 2020;102:1184-8.
69. Sefah IA, Ogunleye OO, Essah DO, Opanga SA, Butt N, Wamaitha A, *et al.* Rapid assessment of the potential paucity and price increases for suggested medicines and protection equipment for COVID-19 Across developing countries with a particular focus on Africa and the implications. Front Pharmacol 2020;11:588106.
70. Haque M, Islam S, Iqbal S, Urmi UL, Kamal ZM, Rahman A, *et al.* 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. Bangladesh J Med Sci 2020;19:S36-S50.
71. Kricorian K, Civen R, Equils O. COVID-19 vaccine hesitancy: Misinformation and perceptions of vaccine safety. Hum Vaccin Immunother 2022;18:1950504.
72. Garett R, Young SD. Online misinformation and vaccine hesitancy. Transl Behav Med 2021;11:2194-9.
73. Loomba S, de Figueiredo A, Piatek SJ, de Graaf K, Larson HJ. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. Nat Hum Behav 2021;5:337-48.
74. Finney Rutten LJ, Zhu X, Leppin AL, Ridgeway JL, Swift MD, Griffin JM, *et al.* Evidence-based strategies for clinical organizations to address COVID-19 vaccine hesitancy. Mayo Clin Proc 2021;96:699-707.
75. Cadogan CA, Hughes CM. On the frontline against COVID-19: Community pharmacists' contribution during a public health crisis. Res Social Adm Pharm 2021;17:2032-5.
76. Hedima EW, Adeyemi MS, Ikunaiye NY. Community Pharmacists: On the frontline of health service against COVID-19 in LMICs. Res Social Adm Pharm 2021;17:1964-6.
77. Erku DA, Belachew SA, Abrha S, Sinnollareddy M, Thomas J, Steadman KJ, *et al.* When fear and misinformation go viral: Pharmacists' role in deterring medication misinformation during the 'infodemic' surrounding COVID-19. Res Social Adm Pharm 2021;17:1954-63.
78. Alzubaidi H, Jirjees FJ, Franson KL, Saidawi W, Othman AM, Rabeeah ZH, *et al.* A global assessment of distance pharmacy education amid COVID-19: Teaching, assessment and experiential training. Int J Pharm Pract 2021;29:633-41.
79. Jandrić P, Hayes D, Truelove I, Levinson P, Mayo P, Ryberg T, *et al.* Teaching in the age of COVID-19. Postdigital Sci Educ 2020;2:1069-230.
80. Nimavat N, Singh S, Fichadiya N, Sharma P, Patel N, Kumar M, *et al.* Online medical education in India – Different challenges and probable solutions in the age of COVID-19. Adv Med Educ Pract 2021;12:237-43.
81. Dhawan S. Online learning: A panacea in the time of COVID-19 crisis. J Educ Technol Syst 2020;49:5-22.
82. Maatuk AM, Elberkawi EK, Aljawarneh S, Rashaideh H, Alharbi H. The COVID-19 pandemic and E-learning: Challenges and opportunities from the perspective of students and instructors. J Comput High Educ 2021;1-18.
83. Armstrong-Mensah E, Ramsey-White K, Yankey B, Self-Brown S. COVID-19 and distance learning: Effects on Georgia State University school of public health students. Front Public Health 2020;8:576227.
84. Al-Balas M, Al-Balas HI, Jaber HM, Obeidat K, Al-Balas H, Aborajooh EA, *et al.* Distance learning in clinical medical education amid COVID-19 pandemic in Jordan: Current situation, challenges, and perspectives. BMC Med Educ 2020;20:341.
85. Hameed T, Husain M, Jain SK, Singh CB, Khan S. Online medical teaching in COVID-19 Era: Experience and perception of undergraduate students. Maedica (Bucur) 2020;15:440-4.
86. Muthuprasad T, Aiswarya S, Aditya KS, Jha GK. Students' perception and preference for online education in India during COVID -19 pandemic. Soc Sci Humanit Open 2021;3:100101.
87. Rafi AM, Varghese PR, Kuttichira P. The pedagogical shift during COVID 19 pandemic: Online medical education, barriers and perceptions in central Kerala. J Med Educ Curric Dev 2020;7:2382120520951795.
88. 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:e0248758.
89. Baral G, Baral RS. E-learning: A modality of medical education in the period of crisis. J Nepal Health Res Counc 2021;18:776-8.
90. Chiodini J. Online learning in the time of COVID-19. Travel Med Infect Dis 2020;34:101669.
91. Henderson D, Woodcock H, Mehta J, Khan N, Shivji V, Richardson C, *et al.* Keep calm and carry on learning: Using Microsoft Teams to deliver a medical education programme during the COVID-19 pandemic. Future Healthc J 2020;7:e67-70.
92. Mian A, Khan S. Medical education during pandemics: A UK perspective. BMC Med 2020;18:100.
93. Jumreornvong O, Yang E, Race J, Appel J. Telemedicine and medical education in the age of COVID-19. Acad Med 2020;95:1838-43.
94. Sharma D, Bhaskar S. Addressing the COVID-19 burden on medical education and training: The role of telemedicine and tele-education during and beyond the pandemic. Front Public Health 2020;8:589669.
95. He L, Yang N, Xu L, Ping F, Li W, Sun Q, *et al.* Synchronous distance education vs. traditional education for health science students: A systematic review and meta-analysis. Med Educ 2021;55:293-308.
96. Azlan CA, Wong JH, Tan LK, Huri MS, Ung NM, Pallath V, *et al.* Teaching and learning of postgraduate medical physics using Internet-based e-learning during the COVID-19 pandemic – A case study from Malaysia. Phys Med 2020;80:10-6.
97. Regmi K, Jones L. A systematic review of the factors – Enablers and barriers – Affecting e-learning in health sciences education. BMC Med Educ 2020;20:91.
98. Papa V, Varotto E, Galli M, Vaccarezza M, Galassi FM. One year of anatomy teaching and learning in the outbreak: Has the COVID-19 pandemic marked the end of a century-old practice? A systematic review. Anat Sci Educ 2022;15:261-80.
99. Nik-Ahmad-Zuky NL, Baharuddin KA, Rahim AF. Online clinical teaching and learning for medical undergraduates during the COVID-19 pandemic: The Universiti Sains Malaysia (USM) experience. Educ Med J 2020;12:75-80.
100. Selvanathan M, Hussin NA, Azazi NA. Students learning experiences during COVID-19: Work from home period in Malaysian Higher Learning Institutions. Teach Public Adm 2020;1-10. [https://journals.sagepub.com/doi/pdf/10.1177/0144739420977900].
101. 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;21:612.
102. Sundarasen S, Chinna K, Kamaludin K, Nurunnabi M, Baloch GM, Khoshaim HB, *et al.* Psychological Impact of COVID-19 and Lockdown among University Students in Malaysia: Implications and Policy Recommendations. Int J Environ Res Public Health 2020;17:E6206.
103. Adesunkanmi AO, Ubom AE, Olasehinde O, Wuraola FO, Ijarotimi OA, Okon NE, *et al.* Impact of the COVID-19 pandemic on surgical residency training: Perspective from a low-middle income country. World J Surg 2021;45:10-7.
104. Gaba F, Blyuss O, Rodriguez I, Dilley J, Wan YL, Saiz A, *et al.* Impact of SARS-CoV-2 on training and mental well-being of surgical gynecological oncology trainees. Int J Gynecol Cancer 2021;31:1268-77.

105. Brown A, Kassam A, Paget M, Blades K, Mercia M, Kachra R. Exploring the global impact of the COVID-19 pandemic on medical education: An international cross-sectional study of medical learners. Can Med Educ J 2021;12:28-43.
106. Alrasheedy AA, Abdulsalim 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;14:729-41.
107. Soliman MM, Aldhaheri S, Neel KF. Experience from a medical college in Saudi Arabia on undergraduate curriculum management and delivery during COVID-19 pandemic. J Nat Sci Med 2021;4:85-9.
108. Altwaijry N, Ibrahim A, Binsuwaidan R, Alnajjar LI, Alsfouk BA, Almutairi R. Distance education during COVID-19 pandemic: A college of pharmacy experience. Risk Manag Healthc Policy 2021;14:2099-110.
109. Shawaqfeh MS, Al Bekairy AM, Al-Azayzih A, Alkatheri AA, Qandil AM, Obaidat AA, *et al.* Pharmacy students perceptions of their distance online learning experience during the COVID-19 pandemic: A cross-sectional survey study. J Med Educ Curric Dev 2020;7:2382120520963039.
110. Chowdhury K, Etando A, Shahwan M, Škrbić R, Jairoun AA, Haque M, *et al*. COVID-19 and the impact on the education of healthcare professionals across countries with a particular focus on developing countries. Bangladesh J Med Sci 2022;21:221-32.
111. O'Sullivan SM, Khraibi AA, Chen W, Corridon PR. Lessons learned transitioning from traditional premedical and medical education to e-learning platforms during the COVID-19 pandemic within the United Arab emirates. J Med Educ Curric Dev 2021;8:23821205211025861.
112. Al Zahrani EM, Al Naam YA, AlRabeeah SM, Aldossary DN, Al-Jamea LH, Woodman A, *et al.* E- Learning experience of the medical profession's college students during COVID-19 pandemic in Saudi Arabia. BMC Med Educ 2021;21:443.
113. Almaiah MA, Al-Khasawneh A, Althunibat A. Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. Educ Inf Technol (Dordr) 2020;25:5261-80.
114. Chowdhury K, Haque M, Lutfor AB, Siddiqui TH, Ahmad R, Sultana I, *et al.* Impact of the COVID-19 pandemic on dental and medical education in Bangladesh: A pilot study and the implications. Bangladesh J Med Sci 2022;21:451-61.
115. Getova A, Mileva E, Angelova-Igova B. Online education during pandemic, according to students from two Bulgarian Universities. Pedagogy 2020;92:211-9.
116. Kaliba M, Ambrožová P. What Do University Students Do in Online Teaching? Reflections On Current Forms of Academic Procrastination, Experience from The Czech Republic. Proceedings of INTED2021 Conference; 2021. p. 357-3361. Available from: https://library.iated.org/view/KALIBA2021WHA. [Last accessed on 2022 Mar 20].
117. Miloshevska L, Gajek E, Džanić ND, Hatipoğlu Ç. Emergency online learning during the first COVID-19 period: Students' perspectives from Bosnia and Herzegovina, North Macedonia, Poland and Turkey. ExELL 2020;8:110-43.
118. Bączek M, Zagańczyk-Bączek M, Szpringer M, Jaroszyński A, Wożakowska-Kapłon B. Students' perception of online learning during the COVID-19 pandemic: A survey study of Polish medical students. Medicine (Baltimore) 2021;100:e24821.
119. Edelhauser E, Lupu-Dima L. One year of online education in COVID-19 age, a challenge for the Romanian education system. Int J Environ Res Public Health 2021;18:8129.
120. Gosak L, Fijačko N, Chabrera C, Cabrera E, Štiglic G. Perception of the online learning environment of nursing students in Slovenia: Validation of the DREEM questionnaire. Healthcare (Basel) 2021;9:998.
121. Baranova S, Nīmante D, Kalniņa D, Oļesika A. Students' perspective on remote on-line teaching and learning at the University of Latvia in the first and second COVID-19 period. Sustainability 2021;13:11890.
122. Sharma P, Chowdhury K, Kumar S, Bhatt R, Hirani T, Duseja S, *et al.* A pilot study regarding the consequence of the COVID-19 pandemic on Healthcare Education in India and the implications. Adv Hum Biol 2022;12:180-9.
123. Chinna K, Sundarasen S, Khoshaim HB, Kamaludin K, Nurunnabi M, Baloch GM, *et al.* Psychological impact of COVID-19 and lock down measures: An online cross-sectional multicounty study on Asian university students. PLoS One 2021;16:e0253059.
124. Saraswathi I, Saikarthik J, Senthil Kumar K, Madhan Srinivasan K, Ardhanaari M, Gunapriya 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.
125. Mulyadi M, Tonapa SI, Luneto S, Lin WT, Lee BO. Prevalence of mental health problems and sleep disturbances in nursing students during the COVID-19 pandemic: A systematic review and meta-analysis. Nurse Educ Pract 2021;57:103228.
126. Basheti IA, Mhaidat QN, Mhaidat HN. Prevalence of anxiety and depression during COVID-19 pandemic among healthcare students in Jordan and its effect on their learning process: A national survey. PLoS One 2021;16:e0249716.

Access this article online

Quick Response Code:

Website: www.aihbonline.com

DOI: 10.4103/aihb.aihb_60_22

How to cite this article: Chowdhury K, Haque M, Etando A, Kumar S, Lugova H, Shahwan M, *et al*. 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;12:87-92.