Original Article

Development of a Haddon Matrix Framework for Higher Education Pandemic Preparedness: Scoping Review and Experiences of Malaysian Universities During the COVID-19 Pandemic

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Managing education and research during pandemics has increased in importance since the onset of epidemics such as avian flu, SARS and now CoViD-19. Successful management in times of crisis ensures business continuity and institutional survival, making preparedness preceding an impending pandemic essential. Institutions of higher education (IHEs) must maintain balance between academic continuity and preventing morbidity during a pandemic crisis. To date, however, no general pandemic preparedness frameworks exist for IHEs. The aim of this paper is to report on the development of a Haddon matrix framework for IHE pandemic preparedness based on a scoping literature review of past IHE responses including pre-, during and post-pandemic phases. First, a review of previous global responses by IHEs during past pandemics was carried out. The review findings were then collated into a new IHE-centric Haddon matrix for pandemic preparedness. The content of the matrix is then illustrated through the documented responses of Malaysian universities during the early stages of the COVID-19 pandemic. The resulting IHE Haddon matrix can be used by universities as a general guide to identify preparedness gaps and intervention opportunities for business continuity during pandemics.

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Introduction

On 31 December 2019, a novel coronavirus was reported to the World Health Organization (WHO) in China. The disease was subsequently named the Coronavirus disease 2019 (COVID-19) in February of 2020. Considered possibly as a “Once-in-a-Century” pandemic with a case fatality risk half of the Spanish flu (Gates, 2020), it poses a greater threat due to its ability to be transmitted by individuals who are not symptomatic (Hoehl et al., 2020). By late March 2020, there were more than 90,000 reported cases worldwide and more than 3000 reported deaths globally making the COVID-19 fatality rate 3.4 percent (Ghebreyesus, 2020). It was expected that these numbers would increase substantially as cases in Europe had yet to be accounted for.

The emergence of past epidemics from viral diseases causing anthropogenic and societal disruptions has raised the issue of business continuity for institutions of higher education (IHE). Many epidemics of emerging or re-emerging viral diseases over the past two decades should have increased the readiness level of IHEs in dealing with pandemics (Reperant and Osterhaus, 2017; Ryu, 2017). A large, cautionary literature on the dangers of potential viral diseases has been in print for over 30 years (Culliton, 1990; Gates, 2015; Morse and Schluederberg, 1990). In response to the challenges created by these re-occurring infectious diseases, especially emerging zoonotic diseases (Taylor et al., 2001), the subject of business continuity and pandemic planning has been raised by both the public and private sectors. These threats have forced entities to plan suitable responses to preserve operational integrity and future existence. Therefore, similar responses should be readily available by IHEs in order to maintain their operational continuity in respect to providing educational services to their students and other stakeholders. Failure to respond adequately can disrupt IHE operations and compromise long-term functionality and viability as well as affect institutional credibility within the learning community. In the context of IHEs, crises such as viral pandemics pose a high risk to the university ecosystem. IHEs are comprised of many people in close contact with one another, facilitating the rapid spread of an infectious agent. On the other hand, IHEs possess a large reservoir of energy and talent in the form of students and academicians that if mobilized correctly, can contribute to risk management during a pandemic (Wang et al., 2020).

The lack of clear planning frameworks and strategies for pandemic preparedness by IHEs has been exposed as a result of the COVID-19 pandemic. COVID-19 has dramatically altered the functioning of IHEs across the globe including reductions in international education, disruption to the academic calendar, cancellation of local and international conferences, teaching and learning gaps, workforce cuts and cuts in higher education budgets (Jacob et al., 2020; Marinoni et al., 2020). Among these disruptions, foremost has been the shift to teaching and learning in an online environment. Much of the IHE-related literature on COVID-19 responses has
reported on the experiences and challenges in shifting to online learning and online pedagogies (Adnan and Anwar, 2020; Dhawan, 2020; Rapanta et al., 2020; Shenoy et al., 2020). In their review of 20 countries’ digital pedagogy responses to COVID-19, Crawford et al. (2020) found a wide range of responses by universities in different countries, from the implementation of very minimum measures (e.g. 1.5-m distance or reduced social gatherings) to the full closure of face-to-face operations and migration to digitalized education. Some universities were already partially prepared for the pandemic given their existing blended or fully online offerings. Outside of teaching and learning, few studies report on university management responses and planning for future pandemics as a result of COVID-19. One exception is a study by Wang et al. (2020), who reported on risk management efforts made by Chinese universities at the early stages of the COVID-19 epidemic. In their response to the pandemic, Chinese universities have emphasized resource collection from alumni, medical rescue and emergency management, mental health maintenance, control of staff mobility and innovation in online education models. To date, no known studies have reported on the use of the Haddon Matrix in an IHE context for COVID-19 pandemic response planning.

The aim of this paper is to report on the development of a tool for IHE pandemic preparedness based on a probing literature review of past IHE responses. First, a review of previous global responses by IHEs during past pandemics was carried out. Second, the review findings were collated into a Haddon matrix. The Haddon matrix has been used to study preparedness against viral outbreaks such as Severe Acute Respiratory Syndrome (SARS) (Barnett et al., 2005a), flu (Barnett et al., 2005b) and Ebola (Phua, 2015). Scenarios in which the Haddon matrix has been used are limited, however, to preparedness for health authorities only. To date, no pandemic preparedness matrix has been developed for IHEs. By combining the features of the original Haddon matrix used for public health institutions with the findings from the scoping review, a new, IHE-centric Haddon matrix for pandemic preparedness was developed. Finally, drawing on literature and observational data of recorded administrative responses to the COVID-19 outbreak by IHEs in Malaysia, we discuss the application of the new IHE-centric matrix framework within the context of Malaysian IHE responses to COVID-19. The proposed matrix is intended to be used in the future by universities as a general guide to identify preparedness gaps and intervention opportunities for business continuity during pandemics.

**Institutions of higher education and pandemic preparation: applicability of the Haddon matrix**

Scientific literature on disaster management tends to proliferate following the occurrence of an epidemic. Examination of the disaster literature landscape using the Lens Database (https://www.lens.org/) from the past 30 years shows that the
number of studies published in scientific journals on flu preparedness surged after every major outbreak (Figure 1) (unpublished data). Thus, an ample amount of scientific material is available to formulate proper responses for IHEs in regard to a global pandemic. In order to better understand the challenges facing IHEs as a result of the CoViD-19 pandemic, the preparedness problem is broken down into the dimensions of time and contributing factors. Responses extracted from the literature on past IHE practices during pandemics can then be mapped into a Haddon matrix.

The Haddon matrix is a public safety model that was developed in the field of injury prevention to reduce morbidity and mortality by standardising safety analysis (Haddon, 1968). The matrix is a two-dimensional grid with four columns and three rows. The first domain of the model involves rows that are divided to represent different phases of an injury [pre-event, event and post-event]. The second domain is known as influencing factors [host, agent/vector, physical environment, social environment] (Table 1). It was the starting analytical matrix for the 2004–2006 World Health Organization (WHO) and Centers for Disease Control’s (CDC) Pandemic Influenza Preparedness Plan until the matrix was expanded to the current six phase framework (Holloway et al., 2014).

Separating a problem into its dimensions of time and contributing factors, the matrix can be utilized as a practical, user-friendly interdisciplinary planning tool to help understand, prepare for and respond to a broad range of public health emergencies (Runyan, 2003). Ever since the Haddon matrix has been adopted from the use of injury prevention to the field of public health readiness and response planning, it has been used to analyse preparedness for diseases such as cholera (Anparasan and Lejeune, 2017), streptococcciosis (Ye-hua, 2006), bioterrorism pathogens (Pappas et al., 2009) and even unique emergencies or disasters such as terrorism (e.g. bombing [Arnold, 2005; Yan and Yu, 2019]), hurricanes (Rogers and Lawhorn, 2007) and sarin attacks (Varney et al., 2006). The scalability of the Haddon Matrix makes it suitable for studying the preparedness of institutions affected by diseases such as nations (Thailand, Israel) (Barnett et al., 2005b), childcare centres (Teng-teng, 2015; Townley and McKnight, 1994), outdoor music festivals (Hutton et al., 2015), industries (e.g. mining (Engström et al., 2018)), agriculture (Rautiainen et al., 2008) and location (e.g. rural or urban settings [Cheng and Xu, 2008]).

**Methodology**

**Study context**

On 16 March 2020, the government of Malaysia announced the nationwide implementation of a 14-day Movement Control Order (MCO) from 18th of March to 31st of March 2020 to control the spread of COVID-19. At the onset, Malaysian
Figure 1. Number of publications for viral diseases H1N1, SARS, MERS-CoV, H7N9 versus flu preparedness.
universities made many proactive decisions including the full closure of campuses. During the early stages of the crisis, government instructions regarding the control and containment of the disease were limited to those from the District Health Office; there was no centralized governmental guidance on managing other aspects of the crisis such as continuity in teaching and learning, managing research, and the welfare of staff and students. Decisions made by many universities were done so on an individual basis by consensus of top management despite most universities having no prior experience in managing disasters of the magnitude of the COVID-19 outbreak. Based on this first-hand experience, the authors were inspired to seek information from the scientific literature on the past experiences of IHEs in

| Phase       | Human factors                                      | Agent/vector                                                                 | Physical environment                                                                 | Sociocultural environment                                                                 |
|-------------|---------------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Pre-event   | Surveillance for influenza and influenza-like     | Genetic and phenotype variation in virulence, transmissibility, host range,   | Hospital infection control infrastructure                                          | Public health infrastructure                                                          |
|             | illness syndrome                                  | and antiviral susceptibility                                                 | Personal protective equipment for health care personnel                              | Infection control practices in health care settings                                      |
|             | Surveillance and monitoring of strains for genetic | Strain pathogenicity to human hosts                                          | Laboratory facilities                                                              |                                                                                         |
|             | and phenotypic changes                            |                                                                               |                                                                                      |                                                                                         |
| Event       | Trained health care and public health personnel   | Infectivity                                                                   | Health care infrastructure surge capacity                                            | Detailed response plan                                                                 |
|             | Health care staff adherence to infection control  | Incubation period                                                            | Stockpiled antivirals, antibiotics and personal protective equipment                  | Criteria for declaring a state of emergency                                             |
|             | protocols                                         | Modes of transmission                                                         | Hospital infection control infrastructure                                          | Public’s psychological preparedness                                                   |
|             |                                                   | Lethality                                                                     |                                                                                      | Public trust in government’s crisis management                                         |
| Post-event  | Post-event risk communication                     | Persistence of agent in environment                                          | Restoration of medication stocks and equipment                                      | Governmental financial and mental health support                                      |
|             | Psychology of post-event reactions                | Genetic drifts                                                                |                                                                                      | Economic impact on affected community                                                  |

Table 1  The use of the Haddon matrix as an analytic and planning tool for pandemic influenza [simplified from Barnett et al. (2005a, b)]
response to disease outbreaks and pandemics. In so doing, the aim was to document the process and outcomes, which could be useful for other IHEs as a general guide for similar future emergency situations.

**Haddon matrix review**

We employed a scoping review of studies on the assessment, preparedness and response by IHEs during epidemics or related emergencies involving infectious diseases. Scoping reviews are often employed for reviewing studies related to disaster preparedness as they can be used to rapidly map the key preparedness points that are too differentiated and broad for a systematic review (Riccardo et al., 2018; Wilson et al., 2012a, b). Studies on disaster preparedness and response by IHEs span across multiple disciplines (e.g. management, education, disaster preparedness, legal) (Anparasan and Lejeune, 2017; Cole et al., 2020; Engström et al., 2018; Kakkar et al., 2010; Zhong et al., 2014). Although we did not employ meta-analysis, systematic review methods were utilized to minimize bias in the identification and inclusion of the studies (Daudt et al., 2013). The comprehensive literature search included the use of a combination of predetermined search criteria, as listed in Table 2. The review was performed during the first MCO period from the 18th of March to 31st of March 2020 using electronic databases Google Scholar (https://scholar.google.com/) and Google (https://www.google.com/). Google is the most comprehensive academic search engine with the largest coverage of literature found in academic search engines and bibliographic databases (ASEBDs), which include subscription-based SCOPUS and Web of Science databases (López-Cózar et al., 2019; Gusenbauer, 2019; Martin-Martin et al., 2017). The collected publications were collated using Mendeley Desktop software package version 1.19.4 (Mendeley Ltd, London, UK) to prevent duplications.

Resulting papers from the initial search were first assessed for relevance. During the initial screening phase, the papers were assessed based on their titles. Studies not relevant to the research topic were excluded. For example, the search protocol returned papers related to studies on the perception and knowledge of diseases among students in health-related fields. These were excluded since they are designed to assess students’ level of knowledge of an ongoing epidemic as part of

| Criteria | Search terms | Timeline criteria |
|----------|--------------|-------------------|
| Action taken by IHE before, during and after the pandemic event | outbreak “university students” - obesity -tobacco -HIV -sexual - “medical students” - “nursing students” awareness, MERS, flu, SARS | 1996–2020 in accordance with epidemic responses recorded by WHO (https://www.who.int/csr/don/archive/year/en/) |
their coursework. In the second phase, abstracts of each paper were assessed for specific inclusion and exclusion criteria. Studies were included if they met any of the following three criteria: (1) the aim was to identify action taken by an affected IHE before, during and after the pandemic event; (2) human, physical and sociocultural factors were discussed; (3) the abstract was written in English. Papers were excluded due to the following reasons: (1) papers published in different journals that contained near identical content (e.g., journal and conference submissions on the same topic); (2) theoretical assessments of pandemic factors not directly related to IHE (e.g., thought experiments); (3) studies based on surveys with members of the public other than IHE staff or student populations; or (4) if IHE staff and students comprised only a portion of the overall sample of respondents. The date of the study was used in the timeline rather than the date of publication as studies may be published significantly later than the actual completion of the study due to lengthy editorial processes.

The factors associated with IHE were identified in each phase (pre-event, event, post-event) and on each axis (human, agent/vector, physical environment, sociocultural environment) and were added into the new IHE matrix. We then identified factors that may be associated with opportunities for IHE intervention, and marked these factors in bold within the matrix, as described by Runyan (2003). The factors were then compared with responses from Malaysian IHE management during the MCO period of the COVID-19 pandemic. Each phase of the pandemic presents a unique set of demands on IHEs in their preparedness and response efforts.

Results and Discussion

Systematic review of IHE responses to past pandemics

The selected search terms produced an initial 30,100 results, which were then reduced by adding exclusion keywords and specific diseases. The selection of “flu”, “MERS” and “H1N1” were used as final criteria to limit the results to virus-related studies. A final 42 published studies were identified from the literature search, and qualified studies were tabulated in an ascending timeline according to country, time of the epidemic, type of disease, sample, recommendations for planning and preparedness in administrative, teaching, research and student affairs, and the study citation (see “Appendix” for full list of studies) (See Figure 2 for selection process).

From the studies selected, recommendations for planning and preparedness were categorized into four main types: administrative, teaching, research and student affairs. Majority of the recommendations focused on welfare of students (76%), followed by recommendations for IHE administrators (40%), recommendations for teaching (7%) and research (5%). IHEs that were affected by an outbreak on their
Figure 2. Selection process of relevant studies.
own campuses (italic rows) accounted for the highest number of recommendations for student welfare. Only three studies recommended switching to distance or online learning, beginning with the 2009–2010 H1N1 outbreak. In their tabletop exercise for flu pandemic planning in 2007, University of Washington administrators recommended the need to reduce the presence of on-site staff through distance learning modalities (Beaton et al., 2007). In their study of staff and student responses to the H1N1 pandemic in Australia, Van et al. (2010) found little use of, and support for, online teaching or learning resources as a result of the pandemic despite student willingness to do so. The authors recommended university support for technologies that allow faculty and students to continue their teaching and learning activities to minimize disruption.

Several studies cited administrative recommendations for pandemic planning. Sixteen of the forty-two studies identified cited administrative recommendations, which included the need for centralized campus operation centres (Beaton et al., 2007); awareness and information dissemination (Salman et al., 2017; Park et al., 2016; Etokidem et al., 2018); the use of electronic and ICT tools for enhancing communication to staff and students (Seale et al., 2011; Ekmekci and Bergstrand, 2010); emphasis on emergency preparedness procedures such as preplanning, and mitigation efforts (Coveleski, 2014; Araz et al., 2011), avoiding oversaturation of information (Koskan et al., 2012; Mitchell et al., 2014), and closing campuses and implementing necessary interventions when deemed necessary (Park et al., 2016; Virk et al., 2017).

Planning and preparation for student affairs centred around the need to have adequate support services for students and staff experiencing anxiety, stress, depression and other mental disorders resulting from pandemics (Wong et al., 2004, 2007; Cheng and Cheung, 2005). Another major area of student affairs planning and preparation included dealing with international and summer school students, who may be stranded on campus during a pandemic outbreak (Beaton et al., 2007). Several papers discussed the need for critical strategies for communicating the importance of adopting public health measures such as hand washing, mask use and avoiding touching the nose and mouth at times of a pandemic (Mitchell et al., 2011; Surgeoner et al., 2009; Gu et al., 2015). Research recommendations were almost completely absent, except for two recommendations on the upkeep and welfare of laboratory animals. The absence of recommendations in teaching and learning could be due to the smaller scale of past outbreaks as compared to the COVID-19 pandemic, the brief time period of past outbreaks and the context of the studies, which centred on only one or a few IHEs.

**Haddon matrix for future IHE pandemic preparedness**

Considering the findings from the systematic review, the Haddon matrix for IHE preparedness was populated and described (Table 3). The agent/vector axis was
| Phase     | Human factors                                                                 | Agent/vector                                                                 | Physical environment                                                                                     | Sociocultural environment                                                                 |
|-----------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Pre-event | Readiness of the student and staff populations to work remotely               | Genetic and phenotype variation in virulence, transmissibility, host range    | Readiness of IHE medical support facilities to test, identify and process infected individuals              | Continuous disaster drills, tabletop exercises and emergency training                         |
|           | Prioritization shift by university management                                   |                                                                               | Teaching and learning materials designed for distance learning especially laboratory or practical lessons | Practicing online/ distance learning and assessment                                             |
|           | Formation of a crisis management team                                          |                                                                               |                                                                                                           |                                                                                           |
| Event     | Trained staff deliver teaching and learning remotely                           | Infectivity Incubation period Modes of transmission Lethality                 | Dedicated Crisis Management Centre (CMC)                                                                  | Detailed IHE response plan                                                                   |
|           | IT staff trained to work remotely                                             |                                                                               | IT infrastructure for online learning                                                                    | Students and staff psychological preparedness                                                 |
|           | Support staff trained to work off-campus or work from home                     |                                                                               | Delivery of materials for distance learning                                                                | Students’ trust in IHE crisis management                                                    |
|           | Support staff to support on-campus quarantined students during travel restrictions |                                                                               | Access to campus laboratory facilities                                                                    | Real-time reporting of location, health status for tracking and data collection              |
|           | International office to assist expatriate or repatriated staff or students     |                                                                               | On-Campus Quarantine facilities                                                                             | Communication strategy to allay anxiety of students and staff                                |
|           | Security to maintain quarantine cordon                                         |                                                                               | Transportation services to ferry students from medical centres                                            | Communication with companies hosting practicum students                                       |
|           |                                                                                 |                                                                               | Equipment for food delivery and medical surveillance                                                     | Material support by research teams to boost morale and create a common goal                  |
identical to previous Haddon matrices describing preparedness against viral infectious agents such as cholera (Anparasan and Lejeune, 2017), Severe Acute Respiratory Syndrome (SARS) (Barnett et al., 2005a), flu (Barnett et al., 2005b) or Ebola (Phua, 2015), and the cells were left plain white.

The development of the new IHE Haddon matrix was performed in three steps. The first step relied on the original Haddon matrix created for flu outbreak preparedness to populate the cells. Each relevant factor in each phase (pre-event, event, post-event) and on each axis (human, agent/vector, physical environment, sociocultural environment) from the original Haddon matrix was added into the matrix. The human factors column refers to staff and students of the IHE. It excludes any individuals not under the direct purview of the IHE such as parents or custodians of students, or governmental officials from health or education departments. The physical environment column refers to the IHE’s physical infrastructure and supporting mechanisms needed to effectively manage a flu pandemic (e.g. ICT facilities for distance learning and the availability of the IHE’s healthcare team). The socio-cultural environment column refers to finance, legal, policy, social and cultural practices in the IHE that affect each phase of disaster response, as each phase represents a unique set of challenges. The socio-cultural environment column refers to the macro-level requirements needed for the IHE to provide an efficient response to the pandemic (e.g. improving the socio-cultural awareness of restricted movement or lockdown, non-pharmaceutical interventions such as hand washing and social distancing).

We next drew on five existing public health-related Haddon matrices that possess an education component in their matrix construction, i.e. those set in nursing schools (Centers for Disease Control, 2002; Tiwari et al., 2006), medical

| Phase          | Human factors                        | Agent/vector                                      | Physical environment                              | Sociocultural environment |
|----------------|--------------------------------------|---------------------------------------------------|---------------------------------------------------|---------------------------|
| Post event     | Post-event risk communication        | Persistence of agent in Environment                | Screening and quarantine facilities for students entering campus housing | Implementation of “lessons learned” |
|                | Psychology of post-event reactions   | Genetic drifts                                     | Decontamination of facilities                     | Functionality of IHE health care |
|                | Post-event influenza-like illness    |                                                    |                                                    | Governmental financial support |
|                | surveillance                         |                                                    |                                                    | Mental health support for staff and students |

Major content [plain text, bold italic] is taken from Barnett et al. (2005a, b), preparedness recommended by past IHEs [italic] and preparedness learned from Malaysian IHE experiences [bold].
schools (Cole et al., 2020; Grosshuesch, 2010) and school transportation services (Edmonston and Sheehan, 2001). We then identified cell items that were not associated with preparedness opportunities for IHEs and removed them. Next, the recommendations extracted from the 42 reviewed studies were organized and summarized according to axis and added to the matrix in Table 3. The third and final step was to remove items not associated with IHE preparedness for flu outbreak from the original matrix and substitute them with similar items that can be adopted by IHEs. Examples of similar items are those related to risks or disasters affecting a campus such as floods (Tkachuck et al., 2018; Zhong et al., 2013), earthquake (Magni et al., 2017), hurricanes (Ladd et al., 2007) and accidents such as radiation leaks (Osburn, 2008). In the final matrix, each cell represents specific task-oriented items that can be designated to the suitable IHE personnel to solve a particular challenge, a method similar to that used by Runyan (2003).

Application of the Haddon matrix for IHE preparedness and planning

Using the pre-, during and post-event phases design of the IHE Haddon matrix as a guide, the following section draws on the experiences of Malaysian IHEs during the COVID-19 pandemic. The purpose is to illustrate how the matrix content can be used to identify gaps in preparedness and response to pandemics for IHEs. We present the three phases below in a narrative format in order to highlight how the scenario unfolded and to allow for discussion with relevant literature and policies. Where appropriate, we also provide recommendations from Malaysia’s experience on how the elements of the Haddon matrix can be applied in other higher education settings.

Pre-event responses

Recent history has seen repeated outbreaks of infectious diseases, from the H1N1 swine flu pandemic to the milder H7N9 bird flu. Fortunately, Malaysia has been largely spared from viral outbreaks, with the exception of the 1998 Nipah virus (Chua, 2003) and a hand, foot and mouth disease (HFMD) outbreak in 2018 (BERNAMA/NSTP, 2018). Unfortunately, the low frequency of outbreaks in Malaysia reduced the country’s perceived threat level, limiting preparedness to public health institutions only. As a member of WHO, however, Malaysia has begun to increase public health preparedness (World Health Organization, 2004) by embracing the vision of the Asia Pacific Strategy for Emerging Diseases (APSED) — a strategic framework for countries to build the required capacity under the International Health Regulations (Li and Kasai, 2011). The Malaysian government further drafted the country’s own strategic document, the Malaysian Strategy for Emerging Diseases (MySED) I Workplan (2012–2015) and MySED II Workplan (2017–2021). However, the need to extend these measures to the creation of infectious disease preparedness plans beyond those for public health institutions...
has only occurred in the context of fiscal plans (e.g. hospitality industry [(AlBattat and MatSom, 2014)]) or in the form of limited measures such as educational instructions kits for undergraduates (as in MySED II). No evident strategic policy documents have been prepared by the Ministry of Education (MOE) or Ministry of Higher Education (MOHE) for responding to infectious disease outbreaks. As a response, Universiti Sains Malaysia (USM) was the first IHE to produce a guideline and action plan for COVID-19 (Hoe, 2020), followed by Universiti Malaysia Kelantan (UMK) (Taskforce, 2020).

In the context of Malaysian IHEs in the pre-event stage, several factors related to the Haddon matrix were critical in defining the readiness level to react to the pandemic. First is medical and health services. At the onset of the outbreak, university medical support facilities initially did not test, identify or process infected individuals but were only tasked to assist on testing samples taken by Ministry of Health (MOH) personnel. The Malaysian government mandated that this was to be performed by the District Health Offices and local hospitals. Subsequently, only ten diagnostic laboratories from Malaysian IHEs had been approved to join the national testing network (Rafidi, 2020). Health centres of universities without medical schools would complement these efforts by providing other health support services. Future preparations should include upgrading and maintaining the necessary standards of these diagnostic laboratories in IHEs.

The second factor is IHE employee readiness in adapting to working remotely. At the time of the outbreak, Malaysian academic work culture was not familiar with remote working as attendance policies — government universities in particular — required all staff to record their daily attendance. Hence, at the time of the COVID-19 outbreak, there were no policies or guidelines in most Malaysian IHEs for working remotely. This caused much confusion among staff. Furthermore, past pre-event preparedness administration emergency training at Malaysian IHEs and their facilities, such as libraries, was limited to scenarios such as fires, electrical outages and floods (Khalid and Dol, 2015) and did not include the unprecedented scale of the COVID-19 scenario pandemic and the paralysing restricted movement nationwide. The COVID-19 pandemic accelerated the IHE’s adoption of distance working and learning practices, that were, at the time of the outbreak, still in development or yet to be implemented on a large scale. IHEs should invest in developing the necessary infrastructure as online learning will constitute a significant portion of teaching and learning in the new COVID-19 and post-COVID-19 environment (Chung et al., 2020).

**Event responses**

The speed of the COVID-19 pandemic, which reached 200 countries in less than 3 months, resulted in a faster infection rate (Liu et al., 2020) and higher lethality than the previous SARS and MERS outbreaks combined (Mahase, 2020). The unique characteristics of COVID-19 caught many governments by surprise, delaying early
responses. In Malaysia, the government instituted a Movement Control Order that initially provided little guidance for IHEs and their respective student bodies. This resulted in thousands of students leaving their university campuses to return to their hometowns. Although a clarification was issued two days later by the Ministry of Higher Education (MOHE), almost all campuses were vacated within 48 hours. Some universities were instructed to close earlier due to the campuses being infected by the Sri Petaling cluster (Lim, 2020; Nordin, 2020). This cluster was the main cause of the second wave of COVID-19 outbreak, which was fuelled by a massive Jemaah Tabligh religious gathering outside Kuala Lumpur (Babulal and Othman, 2020). One university closed its campus prior to the issuance of the national MCO because it was the first campus (Lim, 2020) to report COVID-19 infections, and it reported the highest number of infected cases in Malaysia. This decision proved to be critical in mitigating the spread of the virus as the quarantined students were securely isolated, thus reducing their risk of infecting others by leaving campus and returning home. Other universities issued recommendations for students to stay on campus during the initial period (Harun, 2020) with the rest issuing similar instructions after receiving clarification from the Malaysia Ministry of Higher Education (MOHE) and the National Security Council (MKN). The decision also proved to be controversial, as some universities allowed their students to return home (Anis, 2020), rather than quarantining them on campus for an unknown length of time (Abdul Rahman, 2020). The MCO’s restricted movement strategy was implemented as a compromise between the extremes of a curfew or total lockdown and a complete freedom of movement strategy as initially adopted by Italy and the UK during the early phase of the outbreak (Giordano et al., 2020).

To manage the pandemic, developments were monitored by IHE disaster management teams, usually consisting of senior university management, health services and campus security. These disaster management teams had three main responsibilities: (1) to gather and analyse data on the COVID-19 situation; (2) to prepare a course of action to combat the virus in regard to human capital and university operations; and (3) to relay information of university decisions and actions to IHE staff and students. Malaysian IHEs quickly created various dedicated disaster management teams to manage the effect of the pandemic to their institutions; Universiti Putra Malaysia (UPM) (Rahman, 2020) and Universiti Malaysia Sabah (UMS) (Mukhsam et al., 2020).

IHEs possess a large reservoir of talent, expertise and manpower, which includes staff and students. The size of many university communities can act as both a threat and a resource (Van et al., 2010). In previous pandemics, youth were considered high risk of infection due to their mobility, therefore making outbreak management essential in reducing risk from IHEs to the public. However, during COVID-19 the transmission dynamics differ from previous pandemics. Susceptible individuals and mortality risk are higher among older populations; hence, it was deemed best to isolate students on campus. This proved to be difficult without additional financial
allocations, however, as food needed to be delivered to students during the MCO. Furthermore, in university housing, resident advisors, custodial personnel and food service staff required adequate protection when carrying out services. Most Malaysian IHEs coordinated students remaining on campus into housing arrangements with proper physical distancing to manage their welfare (NewstreamAsia, 2020). Malaysian IHE students that were stranded abroad were also repatriated in coordination with the Education Malaysia office in the respective countries (NST, 2020a, b). Foreign students in Malaysian IHEs were given moral and material support on campus (Abdullah, 2020). The experience, expertise and resources provided by alumni were also tapped by opening support channels to the university. IHE could mobilize student volunteers to help with the distribution of food on campus. In the future, steps should be taken to repatriate local students currently residing abroad to return home as soon as possible.

The re-appropriation of research resources in Malaysian IHEs was used early on to mitigate the effects of the COVID-19 pandemic (Shah et al., 2020). Repurposing research capacity and technology allowed several IHEs to contribute to pandemic management in the early stages. These efforts included the use of robots for delivery and disinfecting (AFP, 2020; BERNAMA, 2020; Rahman, 2020), 3D printing (Choong, 2020), sewing of personal protection equipment (PPE) (New Straits Times, 2020a, b) and laboratory testing (Rafidi, 2020). After the initial pandemic period, IHEs pivoted their research capabilities towards more substantial areas such as genome sequencing and vaccine development. Social science research centred around public perception, mental health and business risks associated with the pandemic (Sundarasen et al., 2020).

As social distancing during the MCO was mandated by law in Malaysia, IHEs encouraged behavioural change such as increased hand washing by creating student awareness and promotional materials. Effective awareness campaigns through social media (Phillipson et al., 2013; Wilson and Huttlinger, 2010) and visual signage (Updegraff et al., 2011) have been shown to successfully reduce infections in student populations. During the early stages of the crisis, many IHEs quickly produced social media-based materials to this effect. Efforts included the provision of hand-washing facilities and social media posters encouraging compliance, and openly distributing bottles of sanitizers to staff and students on campus. Regular information feeds were also used to increase awareness among the students regarding the various crisis management measures being implemented.

The implementation of the MCO resulted in a national lockdown with the exception of ten essential services: food, water, energy, communications and internet, security and defence, solid waste and public cleansing management and sewerage, healthcare and medical — including dietary supplements, banking and finance, e-commerce and logistics. This severe movement restriction forced Malaysia IHE staff members to manage unpredictable and extended disruptions to their usual work practices. It is expected that work productivity will decline due to
the shift to working from home. Understanding academic staff members’ responses to this situation might also aid future crisis planning.

Prior to the COVID-19 pandemic, Malaysian IHE involvement in disaster planning included emergencies such as fires, floods or man-made incidents on their campuses. These experiences can be sourced to provide a framework for pandemic planning as well. Using such disaster planning units as a model for pandemic response, the committee should be chaired by top IHE management and include participation from all department stakeholders. Working groups should be established within the committee to prepare detailed plans for student affairs, medical, academic and administrative operations. The committee should liaise with local and state health agencies via the Director of the University Medical School or Health Centre. In the future, IHEs should consider using training such as the ‘tabletop exercise’ to simulate the emergence of COVID-19 and execute emergency management procedures (Wendelboe et al., 2020). Tabletop exercises are low-cost, discussion-based sessions where participants meet in an informal, classroom setting to react to a simulated scenario. The goal is to enable a response team to react to events as they unfold. During the exercise, participants discuss their respective roles and appropriate responses during an emergency. Tabletop exercises are used to validate organizational emergency planning and capabilities, clarify roles and responsibilities and to identify further mitigation and preparedness requirements (Dausey et al., 2007). When IHEs use the tabletop exercise for planning, government responses such as control and movement restrictions can be considered and planned for.

Post-event responses
The post-event stage in the Haddon matrix deals with the recovery period. This stage includes measures taken to address the possibility of recurring infections and managing the psychological impact of the changes that occurred as a result of the pandemic. This period requires active illness surveillance, making screening and quarantine facilities for students returning to campus housing a requirement. Campus dormitory and administration buildings must also be decontaminated before re-opening. The functionality of IHE health care centres must be fully operational in anticipation of new cases. Financial or material aid should be pursued from both public and private sources to pay for these expenses. Given the high number of infections at certain Malaysian IHEs, campus buildings had to be decontaminated, and ongoing support for staff and students has been extensive. Fatalities due to infection at certain universities required additional support services including counselling for staff and students (Sundarasen et al., 2020). To recover the momentum of teaching and learning, methods of delivery due to physical distancing requirements need to be re-considered. This was particularly true for Malaysian IHEs involved in the teaching of subjects requiring field practice such as clinical courses (Ahmad et al., 2017) and social work (Azman et al., 2020).
**Conclusion**

In the wake of global pandemics and other major health events, national health officials often work to improve their public health capacities by building on the lessons learned to formulate evidence-based strategies for preparedness (Montgomery et al., 2019). In anticipation of future outbreaks, pandemic planning to date has been formulated mostly by business entities and nation states. With the severity of the COVID-19 pandemic, however, planning must now be extended to non-traditional entities such as the education industry (Mounier-Jack and Coker, 2006). The early COVID-19 lessons learned from Malaysian IHEs indicate that IHEs have the capability to adapt their management practices to respond to pandemic events; however, systematic planning and preparation are essential.

In summary, the findings and subsequent recommendations from the scoping review of past IHE responses to pandemics indicate that procedures and policies can be formulated to respond effectively to the pre-event, event and post-event phases, and should include broad management themes with a primary focus on student well-being. The sheer magnitude of the COVID-19 crisis is unprecedented, making past IHE responses as a reference for Haddon matrix inadequate. The IHE Haddon matrix represents an initial attempt to develop a planning and readiness tool specifically for IHEs towards the development of policies relating to institutional responses to global pandemics. Hence, the matrix can be further developed as the COVID-19 pandemic progresses.

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**Compliance with Ethical Standards**

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

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**Appendix: Scoping review of selected studies**
| No. | Disease year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|----------------------|---------|--------------|----------------|-------------------------------------------------------|-----------|
| 1   | Severe Acute Respiratory Syndrome (SARS) 2003 | Hong Kong | 215 students | Investigated perceived stress and psychological responses to the SARS outbreak in healthcare students | Suitable psychological and occupational support services should be made available in case of future outbreaks | Wong et al. (2004) |
| 2   | Severe Acute Respiratory Syndrome (SARS) 2005 | Hong Kong | 763 students in two universities | Assessed the anxiety level and the perceived sources of stress among students from two universities | University that has infected cases on campus has higher anxiety levels than those without cases. Stress management needed to reduce depression and anxiety, should be provided to all students as a preventive measure during future outbreaks | Wong et al. (2007) |
| 3   | Severe Acute Respiratory Syndrome (SARS) 2005 | Hong Kong | 72 students | Examined trait anxiety, coping flexibility, and situation-specific coping as predictors of changes in the state of anxiety over time | Anxiety levels will fluctuate during crisis/pandemic | Cheng and Cheung (2005) |
### continued

| No. | Disease year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|-----------------------|---------|--------------|----------------|------------------------------------------------------|-----------|
|     |                       |         |              |               | Administrative | Teaching | Research | Students Affairs |                                     |           |
| 4   | Haemorrhagic fever with renal syndrome (HFRS) 2006 | China   | Infected students, wild and laboratory rodents | Characterize etiologic agents of the outbreak and clarify the origin of hantaviruses causing infections in humans and laboratory animals | – | – | HFRS caused by SEOV in local wild rats had infected the laboratory rats | – | Zhang et al. (2009) |
| 5   | Scenarios of a flu outbreak in Southeast Asia affecting UW operations 2009 | USA     | 50 university administrators | Table top exercise scenario, storyboards, and messages were strategically developed to address the exercise objectives and to cover all phases of a pandemic influenza event | 1. Need for a Campus Emergency Operations Centre (EOC) that can function remotely 2. IHE emergency plan lacked formal selection and training procedures 3. IHEs can never be closed entirely for medical centre and “stranded” in-resident international students and staff | Reduction of on-site staff through extra classroom learning modalities | Ensure continuity of care for laboratory research animals | International students and visiting faculty and scholars who are stranded during a pandemic will rely on the university for critical services during a pandemic | University planning must consider the human and emotional needs of international students and faculty | Beaton et al. (2007) |
| No. | Disease year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|----------------------|---------|--------------|---------------|-------------------------------------------------------|------------|
| 6   | H1N1 2009            | Korea   | 101 students | Identify the relationship between knowledge, attitude, and compliance with preventive behaviours | Perceived knowledge and attitude may be necessary to improve compliance with preventive behaviour and can be achieved through educational programs | Choi and Yang (2010) |
| 7   | H1N1 2009            | Australia | 20 domestic and international students | Examine the knowledge, attitudes, risk perceptions, practices and barriers towards influenza and infection control strategies | Students need to be informed about disease transmission and about risk of infection | Scale et al. (2012) |
| 8   | H1N1 2009            | UK      | 276 international students | Disease transmission | Increased risk in twin bedrooms | Infection reduced by lack of 'social identity' between summer school students. Being new students, they tend to keep to themselves or stick with their nationalities. | Arinaminpathy et al. (2012) |
| 9   | H1N1 2009            | Korea   | 942 students | Assess the perceptions, motivating factors, and behaviours associated with the use of hand washing | 1. Increased frequency of hand hygiene practices during the pandemic 2. Significant gender differences in students' attitudes and behaviours | Park et al. (2010) |
| No. | Disease year of study | Country | Study sample | Theme of study                                                                 | Findings/recommendations for planning and preparedness                                                                 | Reference |
|-----|-----------------------|---------|--------------|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------|
| 10  | H1N1 2009             | USA     | 6049 students| Assess knowledge of and adherence to university-recommended nonpharmaceutical interventions (NPIs) | Cancellation of university events 1. Wash hands often and cover mouth when coughing 2. Reduce risk of illness when caring for ill students 3. Encouraged vaccination | Mitchell et al. (2011) |
| 11  | Norovirus 2009        | Canada  | 357 students | Assess compliance with hand hygiene recommendations at the height of a suspected norovirus outbreak | – – – A current and thorough crisis communications and management strategy, targeted at a university student audience and supplemented with proper hand washing tools, should be enacted by residence administration | Surgeoner et al. (2009) |
| 12  | H1N1 2009             | China   | 825 students from 2 universities | Investigated the level of mental distress and the prevalence of using preventive measures among university students | – – – Prevalence of adopting public health measures such as hand washing, mask use, and avoiding touching the nose and mouth at times of a pandemic needs to be increased | Gu et al. (2015) |
| 13  | H1N1 2009             | Norway  | 501 students | Explore reflections of students on the risk assessment of seasonal flu and swine flu in 2009 | – – – Students would rather follow advice about their personal hygiene than advice to take the swine flu-vaccine | Berg et al. (2014) |
| No. | Disease year of study | Country | Study sample | Theme of study                                                                 | Findings/recommendations for planning and preparedness                                                                                                                                                                                                 | Reference |
|-----|-----------------------|---------|--------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 14  | H1N1 2009             | China   | 1082 students from 4 provinces throughout China | Evaluate the predictors of stress symptoms using PTSD (posttraumatic stress disorder) questionnaire | Stress symptoms are related to the degree of exposure to a stressful event                                                                                                                                                                                                 | Xu et al. (2011) |
| 15  | H1N1 2009             | USA     | 175 students | Determine influenza and seasonal influenza knowledge, attitudes, and health communication strategies | 1. Students did not perceive dormitory living to be a greater health risk, even by sharing bathrooms and sleeping quarters
2. Students acquire health information using informal support networks and electronic social networking | Wilson & Huttlinger (2010) |
| No. | Disease, year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|------------------------|---------|--------------|---------------|------------------------------------------------------|-----------|
| 16  | H1N1 2010              | Australia | 2882 Staff and students | Perceptions and responses towards pandemic (H1N1) | 1. Expanding online teaching and learning resources for continuing education in disaster settings 2. Creating additional support for technologies that minimize disruption | Van et al. (2010) |
| 17  | H1N1 2010              | USA     | 20 university business continuity plans | The role of IT as an enabler of agility and how they use IT infrastructure to ensure that they were sufficiently flexible to deal with the potential crisis of the future H1N1 outbreak. | IT flexibility requires the ability to simultaneously change the speed and direction of organizational change | Ekmekci and Bergstrand (2010) |
| No. | Disease year of study | Year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|-----------------------|---------------|---------|--------------|---------------|------------------------------------------------------|-----------|
| 18  | H1N1                  | 2010          | Turkey  | 402 students | Assessed knowledge of and attitudes towards H1N1, vaccination and other preventive measures | Promote positive health behaviour among students compatible with international guidelines through a dedicated channel | Akan (2010) |
| 19  | H1N1                  | 2011          | USA     | 483 students | Assessed university students’ self-reported knowledge, behaviour, and behavioural intention with respect to H1N1 | – | 1. Campaigns should provide facts that differentiate between regular flu and H1N1 influenza 2. Emphasize the importance of vaccination and self-isolation rather than hygiene 3. Increase in dissemination efforts towards younger, male students | Soto Mas et al. (2011) |
| 20  | H1N1                  | 2011          | USA     | 514 students | Assessed attitudes towards vaccination | – | Campus psychologists may help address lack of knowledge of vaccination safety, effectiveness, and necessity among students | Ramsey and Marczinski (2011) |
| No. | Disease year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|----------------------|---------|--------------|----------------|------------------------------------------------------|-----------|
| 21  | H1N1 2011            | India   | 802 students | Assessed knowledge, attitude and willingness to accept post-pandemic vaccination | – | – | – | Need to provide accessible information as vaccination coverage among students remains very low in the post-pandemic period | Suresh et al. (2011) |
| 22  | H1N1 2011            | Australia | 2883 staff and students | Measured the awareness and receptiveness of staff and students towards university information broadcasts about the H1N1 situation | 1. University officials need to seek a middle ground between inciting unnecessary fear and promoting complacency 2. Electronic communication may be the most efficient way | – | – | – | Scale et al. (2011) |
| No. | Disease year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|----------------------|---------|--------------|----------------|-----------------------------------------------------|-----------|
| 23  | Pandemic flu 2011    | USA     | 47,300 commuting students and 7700 residential students. | IHE is simulated for multiple non-pharmaceutical interventions such as social distancing including suspending university operations, evacuating dorms and isolation of infected individuals on campus. | 1. Even during a mild pandemic, the decision to suspend university operations is critical. 2. Public universities should act as early as possible to protect their community and secure their operations. Time for evacuation of the dorms may have a significant impact on the number of infections and mortalities. | Araz et al. (2011) |
| 24  | H1N1 2011            | Egypt   | 1312 students | Assess the knowledge, attitudes and practices of El-Minia University students regarding H1N1 and its preventive measures. | - | Efforts to inform students about specific actions that can reduce risks. | Kamal and Seedhom (2011) |
| 25  | Seasonal flu and H1N1 2012 | USA | 1190 students | Disease perception | - | Undergraduates may require additional information during novel influenza pandemics. | Maier et al. (2012) |
| No. | Disease | Year | Country | Study Sample | Theme of Study | Findings/Recommendations for Planning and Preparedness | Reference |
|-----|---------|------|---------|--------------|----------------|-----------------------------------------------------|-----------|
| 26  | H1N1    | 2012 | Japan   | 11,424 students | Disease transmission among students at Shinshu University | Main transmission route was associated with club activity | Uchida et al. (2012) |
| 27  | H1N1    | 2012 | USA     | 629 students  | Study to determine if the presence of an influenza pandemic increased awareness of the ongoing influenza pandemic. | Presence of an ongoing influenza pandemic will not increase overall knowledge levels and vaccination behaviours of students | Schlenker et al. (2013) |
| 28  | Mumps   | 2012 | Netherlands | 989 students from Delft, Leiden and Utrecht | Investigation of a mumps outbreak within a highly vaccinated university student population | Intense social mixing during parties Dense communal living environment of the students | Greenland et al. (2012) |
| 29  | Measles | 2014 | Korea   | 1691 staff and students | Estimate vaccine effectiveness | Under-immunity among young adult population needs to be improved | Choe (2017) |
| No. | Disease year of study | Country | Study sample | Theme of study                                      | Findings/recommendations for planning and preparedness | Reference |
|-----|-----------------------|---------|--------------|----------------------------------------------------|------------------------------------------------------|------------|
| 30  | H1N1 2014             | USA     | 60 students  | Responses to pandemic emergency preparedness information | Oversaturation of information can lead decrease in students' perceived importance of disaster prevention information | Universities should rely on interpersonal communication and mediated communication from trusted sources | Koskan et al. (2012) |
| 31  | H1N1 2014             | USA     | 48 students  | Describe student and faculty attitudes towards and adherence to nonpharmaceutical control measures during an outbreak on university campus | Limited information regarding A(H1N1), insufficient understanding of university decisions, and perceived university alert overuse led to reports that future outbreaks would be regarded less seriously | Mitchell et al. (2014) |
| No. | Disease year of study | Country   | Study sample | Theme of study                                                                 | Findings/recommendations for planning and preparedness | Reference                        |
|-----|----------------------|-----------|--------------|-------------------------------------------------------------------------------|-------------------------------------------------------|----------------------------------|
|     |                      |           |              | Administrative                                                                 | Teaching                                             | Interaction                     |
|     |                      |           |              | Research                                                                      | Students Affairs                                     |                                  |
|     |                      |           |              |                                                                               |                                                      |                                  |
| 32  | Disaster Plans       | USA       | 83 students  | To utilize transformational leadership theory as a way to explore students’ perceptions of natural disaster plans and emergency preparedness | Emphasis of emergency preparedness procedures such as preplanning, and mitigation efforts by leadership personnel. | Coveleski (2014)                 |
|     | and Emergency        |           |              |                                                                               |                                                      |                                  |
|     | Preparedness         |           |              |                                                                               |                                                      |                                  |
| 33  | MERS 2015            | Korea     | 1470 students| Examined the sources of confusion during outbreak and identified the factors that can affect people’s behaviour | Building trust and sharing knowledge are important to ensure a rapid response to disease outbreaks, and to prevent unnecessary behaviours | Yang and Cho (2017)              |
|     |                      |           |              |                                                                               |                                                      |                                  |
| 34  | H1N1 2015            | Malaysia  | 40 students  | Assess knowledge of swine flu                                                  | –                                                    | Address misconceptions about infection | Al-Naggar et al. (2015)          |
| 35  | Ebola 2015           | Malaysia  | 458 staff and student | Assess level of knowledge and perception                                        | Need to raise awareness among university population | Etokidem et al. (2018)                  |
| No. | Disease year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|-----------------------|---------|--------------|----------------|------------------------------------------------------|-----------|
|     |                       |         |              | Administrative | Teaching | Research | Students Affairs |                                      |
| 36  | MERS 2016             | Korea   | 120 medical students attached to hospitals | Risk of disease to medical students | 1. Immediate school closure  
2. Open communication with faculty and staff | 1. Instant cessation of clinical clerkships at affected hospitals  
2. Rearranged the clerkships to another hospital  
3. Distance learning — lectures and tutorials | Maintain open communication with students | Park et al. (2016) |
| 37  | MERS 2016             | Qatar   | 33 female students | Examine the level of students’ knowledge | – | – | – | Comprehensive educational interventions are needed to facilitate adoption of precautions associated with MERS-COV | Al-Muhalda et al. (2016) |
| No. | Disease year of study | Country  | Study sample | Theme of study                                                                 | Findings/recommendations for planning and preparedness                                                                 | Reference |
|-----|-----------------------|----------|--------------|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------|
| 38  | H1N1 2016             | Singapore| 34 genomes   | To determine the phylogeography of influenza viruses on a university campus    | Virus clustering on campus is a marker for possible closure of large institutions or introduction of on-campus interventions such as quarantine of hostels, cancellation of lectures, and shutdown of canteen areas | Virk et al. (2017) |
| 39  | Ebola 2017            | Pakistan | 1647 staff and students | Evaluate knowledge regarding Ebola virus | The need to use multidimensional awareness campaigns via print, electronic, and social media | – |
|     | –                     | Salman et al. (2017) | – | – | – | – |
| 40  | H1N1 2017             | Pakistan | 80 students | Knowledge, practice and barriers of using facemasks among university students | – | – | – | Need to increase awareness about risk of respiratory infection especially in male students | Ahmad et al. (2017) |
| No. | Disease year of study | Country | Study sample | Theme of study | Findings/recommendations for planning and preparedness | Reference |
|-----|-----------------------|---------|--------------|----------------|------------------------------------------------------|---------|
| 41  | Varicella Zoster Virus 2018 | India   | 110 infected staff and students | Investigated a yearlong varicella zoster virus outbreak in a highly susceptible young adult population at a large university (40,000 students) | 1. Young adult population living in a densely populated campus setting, adequate infection control strategies must be practiced 2. Close contact on campus adherence to infection control procedures was poor, possibly leading to increased transmission | Meyers et al. (2018) |
| 42  | MERS 2018 | Saudi Arabia | 733 students | Knowledge and attitude were assessed | 1. Females had better knowledge than males 2. Medical students are more knowledgeable than non-medical students | Tork and Mersal (2018) |

Italic rows denote studies reporting outbreaks occurring on IHE campuses.