




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), streptococciosis (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

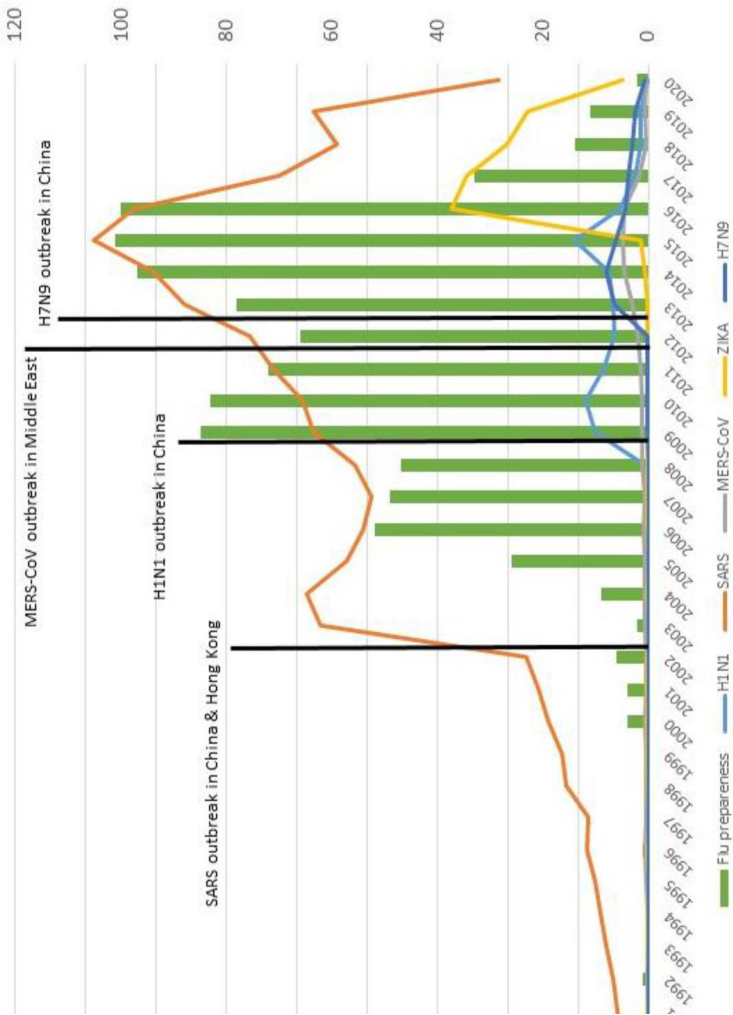


Figure 1. Number of publications for viral diseases H1N1, SARS, MERS-CoV, H7N9 versus flu preparedness.



Table 1 The use of the Haddon matrix as an analytic and planning tool for pandemic influenza [simplified from Barnett *et al.* (2005a, b)]

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

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

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

Table 2 Predetermined search criteria used in the systematic literature review

<i>Criteria</i>	<i>Search terms</i>	<i>Timeline criteria</i>
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

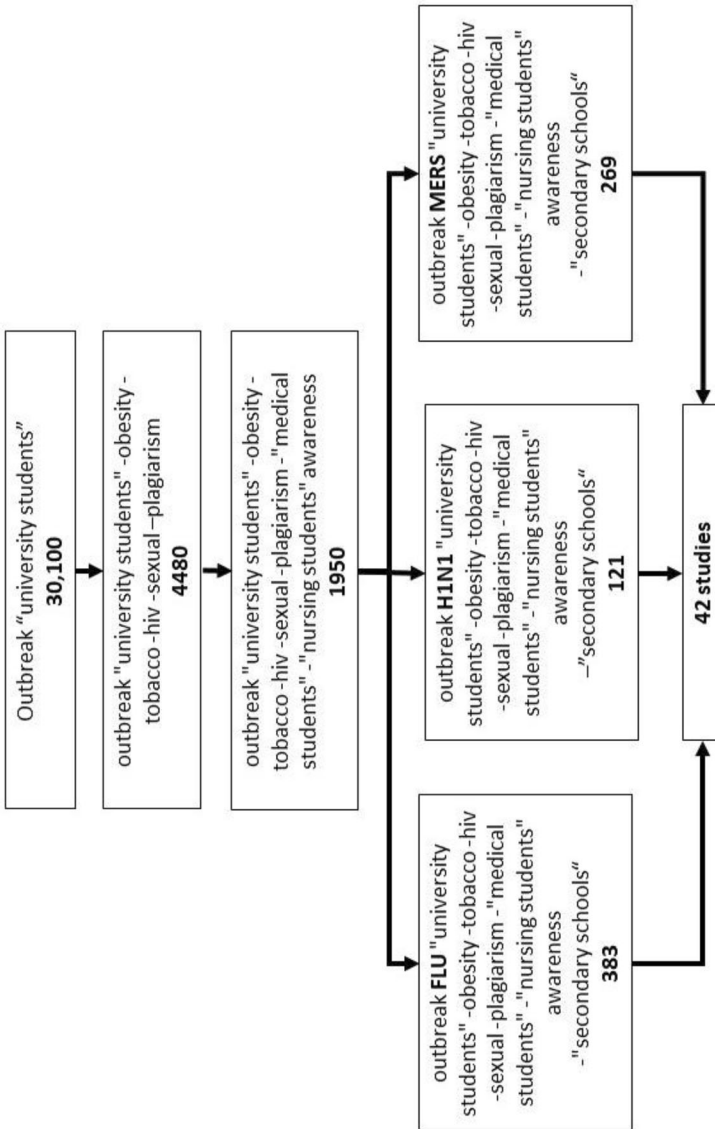


Figure 2. Selection process of relevant studies.



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

Table 3 Haddon matrix for IHE preparedness and planning for flu pandemic

<i>Phase</i>	<i>Human factors</i>	<i>Agent/vector</i>	<i>Physical environment</i>	<i>Sociocultural environment</i>
Pre-event	<i>Readiness of the student and staff populations to work remotely</i> <i>Prioritization shift by university management</i> <i>Formation of a crisis management team</i>	<i>Genetic and phenotype variation in virulence, transmissibility, host range</i>	Readiness of IHE medical support facilities to test, identify and process infected individuals Teaching and learning materials designed for distance learning especially laboratory or practical lessons	<i>Continuous disaster drills, tabletop exercises and emergency training</i> Practicing online/ distance learning and assessment
Event	<i>Trained staff deliver teaching and learning remotely</i> IT staff trained to work remotely Support staff trained to work off-campus or work from home Support staff to support on-campus quarantined students during travel restrictions International office to assist expatriate or repatriated staff or students Security to maintain quarantine cordon	<i>Infectivity</i> <i>Incubation period</i> <i>Modes of transmission</i> <i>Lethality</i>	<i>Dedicated Crisis Management Centre (CMC)</i> <i>IT infrastructure for online learning</i> Delivery of materials for distance learning Access to campus laboratory facilities On-Campus Quarantine facilities Transportation services to ferry students from medical centres Equipment for food delivery and medical surveillance Decontamination equipment Laboratory maintenance during lockdown	<i>Detailed IHE response plan</i> <i>Students and staff psychological preparedness</i> <i>Students' trust in IHE crisis management</i> Real-time reporting of location, health status for tracking and data collection Communication strategy to allay anxiety of students and staff Communication with companies hosting practicum students Material support by research teams to boost morale and create a common goal



Table 3 *continued*

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

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

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 (Sundarasan *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 (Sundarasan *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.

References

- Abdul Rahman, D. A. (2020) 'COVID-19: UniMAP sedia 30 bas hantar pelajar pulang', *Berita Harian*, 18 March.
- Abdullah, M. F. (2020) 'Staying on campus during MCO a strain on students', *New Straits Times*, 14 April.
- Adnan, M. and Anwar, K. (2020) 'Online learning amid the COVID-19 pandemic: students' perspectives', *Online Submission* 2(1): 45–51.
- AFP. (2020) "'Medibot' to do rounds on Malaysia's Covid-19 wards', *New Straits Times*, 13 April.

- Ahmad, I., Altaf, S. and Ahmad, H. M. (2017) 'Assessment of knowledge, practice and barrier in use of facemask among university students', *Pakistan Journal of Medical & Health Sciences* 11(4): 1657–58.
- Akan, H. (2010) 'Knowledge and attitudes of university students toward pandemic influenza: a cross-sectional study from Turkey', *BMC Public Health* 10(1): 413.
- Al-Muhafda, Z., Qaher, M., Faisal, E., Abushahla, H., Kurdi, R. and Al-Jayyousi, G. (2016) 'Knowledge of MERS-Corona Virus among female students at Qatar University', In *Qatar Foundation Annual Research Conference Proceedings Volume 2016 Issue 1* (Vol. 2016, No. 1, p. HBSP3348). Hamad bin Khalifa University Press (HBKU Press).
- Al-Naggar, R. A., Al Jashamy, K. and Bobryshev, Y. V. (2015) 'Knowledge of Malaysian university students towards Swine-Origin Influenza A (H1N1) Virus: a qualitative study', *International Archives of Medicine* 8(12): 1–7.
- AlBattat, A. R. and MatSom, A. P. (2014) 'Emergency planning and disaster recovery in Malaysian hospitality industry', *Procedia - Social and Behavioral Sciences* 144: 45–53.
- Anis, M. N. (2020) 'Covid-19: move to send UPSI students home temporarily halted', *The Star*, 14 May.
- Anparasan, A. and Lejeune, M. (2017) 'Analyzing the response to epidemics: concept of evidence-based Haddon Matrix', *Journal of Humanitarian Logistics and Supply Chain Management* 7(3): 266–283.
- Araz, O. M., Lant, T., Fowler, J. W. and Jehn, M. (2011) 'A simulation model for policy decision analysis: a case of pandemic influenza on a university campus', *Journal of Simulation* 5(2): 89–100.
- Arinaminpathy, N., Raphaely, N., Saldana, L., Hodgekiss, C., Dandridge, J., Knox, K. and McCarthy, N. D. (2012) 'Transmission and control in an institutional pandemic Influenza A(H1N1) 2009 outbreak', *Epidemiology and Infection*, 140(6): 1102–1110.
- Arnold, J. L. (2005) 'The 2005 London bombings and the Haddon Matrix', *Prehospital and Disaster Medicine* 20(5): 278–81.
- Azman, A., Jamir Singh, P. S., Parker, J. and Crabtree, S. A. (2020) 'Addressing competency requirements of social work students during the COVID-19 pandemic in Malaysia', *Social Work Education* advance online publication August 28. <https://doi.org/10.1080/02615479.2020.1815692>.
- Babulal, V. and Othman, N. Z. (2020) 'Sri Petaling Tabligh gathering remains Msia's largest Covid-19 cluster', *New Straits Times*, 11 April.
- Barnett, D. J., Balicer, R. D., Lucey, D. R. Everly Jr, G. S., Omer, S. B., Steinhoff, M. C. and Grotto, I. (2005b) 'A systematic analytic approach to pandemic influenza preparedness planning', *PLoS Med* 2(12): e359.
- Barnett, D. J., Balicer, R. D., Blodgett, D., Fewes, A. L., Parker, C. L. and Links, J. M. (2005a) 'The application of the Haddon Matrix to public health readiness and response planning', *Environmental Health Perspectives* 113(5): 561–566.
- Beaton, R., Stergachis, A., Thompson, J., Osaki, C., Johnson, C., Charvat, S. J. and Marsden-Haug, N. (2007) 'Pandemic policy and planning considerations for universities: findings from a tabletop exercise', *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science* 5(4): 327–334.
- Berg, J. E., Grimeland, J. and Jacobsen, I. W. (2014) 'Risk perception of seasonal and swine influenza among university college students: does study direction influence attitudes', *Journal of Health Science* 2: 89–93.
- BERNAMA. (2020) 'UTM, partners create 'makkiah 19' delivery robot', 8 April.
- BERNAMA/NSTP. (2018) 'HFMD cases near 38,000 nationwide since January', *New Straits Times*, 28 July.
- Centers for Disease Control. (2002) 'Bioterrorism and emergency readiness: competencies for all public health workers', <https://www.hsdl.org/?abstract&did=770983>.
- Cheng, C. and Cheung, M. W. L. (2005) 'Psychological responses to outbreak of severe acute respiratory syndrome: a prospective, multiple time-point study', *Journal of Personality* 73(1): 261–85.
- Cheng, Q. and Xu, Y. (2008) 'The application of the Haddon Matrix model in the health education of rural emergent events in China', *Modern Preventive Medicine* 20.



- Choe, Y. J. 2017. "An outbreak of Measles in a University in Korea, 2014." *Journal of Korean Medical Science* 32(11): 1876–1878.
- Choi, J. S. and Yang, N. Y. (2010) 'Perceived knowledge, attitude, and compliance with preventive behavior on influenza A (H1N1) by university students', *Korean Journal of Adult Nursing* 22(3): 250–259.
- Choong, J. (2020) 'Health Ministry, UTM collaborate on three projects for Covid-19 Care', *Malay Mail*, 13 April.
- Chua, K. B. (2003) 'Nipah Virus outbreak in Malaysia', *Journal of Clinical Virology* 26(3): 265–275.
- Chung, E., Subramaniam, G. and Christ Dass, L. (2020) 'Online learning readiness among university students in Malaysia amidst Covid-19', *Asian Journal of University Education* 16(2): 45–58.
- Cole, G., Rosenblum, A. J., Boston, M. and Barnett, D. J. (2020) 'Applying the Haddon Matrix to hospital earthquake preparedness and response', *Disaster Medicine and Public Health Preparedness* advance online publication April 7 <https://doi.org/10.1017/dmp.2020.30>.
- Coveleski, J. (2014) 'A study of students' perceptions of natural disaster plans and emergency preparedness at a higher education institution', Ph.D. dissertation, Department of Educational Leadership and Policy Studies, Florida State University.
- Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P. and Lam, S. (2020). 'COVID-19: 20 countries' higher education intra-period digital pedagogy responses', *Journal of Applied Learning & Teaching* 3(1): 1–20.
- Culliton, B. J. (1990) 'Emerging viruses, emerging threat', *Science* 247: 279+.
- Daudt, H. M. L., Van Mossel, C. and Scott, S. J. (2013) 'Enhancing the Scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework', *BMC Medical Research Methodology* 13(1): 48.
- Dausey, D. J., Buehler, J. W. and Lurie, N. (2007) 'Designing and conducting tabletop exercises to assess public health preparedness for manmade and naturally occurring biological threats', *BMC Public Health* 7(1): 92.
- Dhawan, S. (2020) 'Online learning: A panacea in the time of COVID-19 crisis', *Journal of Educational Technology Systems* 49(1): 5–22.
- Edmonston, C. J. and Sheehan, M. C. (2001) 'Safe school travel is no accident! Applying the Haddon Matrix to school transport safety', In *Proceedings of the 2001: Road Safety Research, Policing and Education Conference Volume 2* (pp. 110–117). Conference Management Office Monash University.
- Ekmekci, O. and Bergstrand, J. (2010) 'Agility in higher education: planning for business continuity in the face of an H1N1 pandemic', *SAM Advanced Management Journal* 75(4): 20.
- Engström, K. G., Angrén, J., Björnstig, U. and Saveman, B. I. (2018) 'Mass casualty incidents in the underground mining industry: applying the Haddon Matrix on an integrative literature review', *Disaster Medicine and Public Health Preparedness* 12(1): 138–146.
- Etokidem, A. J., Ago, B. U., Mgbekem, M., Etim, A., Usoroh, E. and Isika, A. (2018) 'Ebola virus disease: assessment of knowledge, attitude and practice of nursing students of a Nigerian University', *African health sciences*, 18(1): 55–65.
- Gates, B. (2015) 'The next epidemic— lessons from Ebola', *New England Journal of Medicine* 372(15): 1381–1384.
- Gates, B. (2020) 'Responding to Covid-19 - a once-in-a-century pandemic?', *The New England Journal of Medicine* 382(18): 1677–1679.
- Ghebreyesus, T.A. (2020) 'WHO Director-General's opening remarks at the media briefing on COVID-19', <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19> 3-march-2020, accessed 24 March 2020.
- Giordano, G., Blanchini, F., Bruno, R., Colaneri, P., Di Filippo, A., Di Matteo, A. and Colaneri, M. (2020) 'Modelling the COVID-19 epidemic and implementation of population-wide interventions in Italy', *Nature Medicine*, 1–6.

- Greenland, K., Whelan, J., Fanoy, E., Borgert, M., Hulshof, K., Yap, K. B. and Hahné, S. (2012) 'Mumps outbreak among vaccinated university students associated with a large party, the Netherlands, 2010', *Vaccine* 30(31): 4676–4680.
- Grosshuesch, A. R. (2010) 'Staffing a major academic medical center during a long term disaster', Ph.D. Dissertation, Department of Psychology, Appalachian State University.
- Gu, J., Zhong, Y., Hao, Y., Zhou, D., Tsui, H., Hao, C. and Lau, J. T. F. (2015) 'Preventive behaviors and mental distress in response to H1N1 among university students in Guangzhou, China', *Asia Pacific Journal of Public Health* 27(2): NP1867–NP1879.
- Gusenbauer, M. (2019) 'Google Scholar to overshadow them all? comparing the sizes of 12 academic search engines and bibliographic databases', *Scientometrics* 118(1): 177–214.
- Haddon, W. (1968) 'The changing approach to the epidemiology, prevention, and amelioration of trauma: the transition to approaches etiologically rather than descriptively based', *American Journal of Public Health and the Nations Health* 58(8), 1431–1438.
- Harun, H. N. (2020) 'USM students urged to stay put', *New Straits Times*, 12 April.
- Hoe, T.E. (2020) 'USM first university in Malaysia to devise guideline and action plan on COVID-19 Pandemic', *USM News*, 3 April.
- Hoehl, S., Rabenau, H., Berger, A., Kortenbusch, M., Cinatl, J., Bojkova, D. and Neumann, P. (2020) 'Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China', *New England Journal of Medicine* 382(13): 1278–1280.
- Holloway, R., Rasmussen, S. A., Zaza, S., Cox, N. J., Jernigan, D. B. and Influenza Pandemic Framework Workgroup. (2014) 'Updated preparedness and response framework for influenza pandemics', *Morbidity and Mortality Weekly Report: Recommendations and Reports* 63(6): 1–18.
- Hutton, A., Savage, C., Ranse, J., Finnell, D. and Kub, J. (2015) 'The use of Haddon's matrix to plan for injury and illness prevention at outdoor music festivals', *Prehospital and Disaster Medicine* 30(2): 175.
- Jacob, O. N., Abigeal, I. and Lydia, A. E. (2020) 'Impact of COVID-19 on the higher institutions development in Nigeria', *Electronic Research Journal of Social Sciences and Humanities* 2(2): 126–135.
- Kakkar, M., Hazarika, S., Zodpey, S. and Reddy, K. S. (2010) 'Influenza pandemic preparedness and response: A review of legal frameworks in India', *Indian Journal of Public Health* 54(1), 11.
- Kamal, N. N. and Seedhom, A. E. (2011) 'Knowledge, attitude and practice of El-Minia university students towards pandemic H1N1, Egypt, 2009', *Journal of Public Health* 19(6): 505–510.
- Khalid, S. J. M. and Dol, N. (2015) 'Disaster preparedness for academic libraries in Malaysia: an exploratory study', *International Journal of Humanities and Social Sciences* 9(10): 2946–2952.
- Koskan, A., Foster, C., Karlis, J. and Tanner, A. (2012) 'Characteristics and influences of H1N1 communication on college students', *Disaster Prevention and Management: An International Journal* 21(4): 418–432.
- Ladd, A. E., Gill, D. A. and Marszalek, J. (2007) 'Riders from the storm: Disaster narratives of relocated New Orleans college students in the aftermath of Hurricane Katrina', *Journal of Public Management and Social Policy* 13(2): 51–80.
- Li, A. and Kasai, T. (2011) 'The Asia Pacific strategy for emerging diseases—a strategy for regional health security', *Western Pacific Surveillance and Response Journal: WPSAR* 2(1): 6.
- Lim, I. (2020). 'Covid-19: Johor's UTHM suspends lessons, gatherings after one university staff tests positive', *Malay Mail*, 15 March.
- Liu, Y., Gayle, A. A., Wilder-Smith, A. and Rocklöv, J. (2020) 'The reproductive number of COVID-19 is higher compared to SARS coronavirus', *Journal of Travel Medicine*, 1–4.
- López-Cózar, E. D., Orduña-Malea, E. and Martín-Martín, A. (2019) 'Google Scholar as a data source for research assessment.' In *Springer handbook of science and technology indicators* (pp. 95–127). Springer, Cham.



- Magni, M., Fraboni, R. and Marincioni, F. (2017) 'Emergency preparedness and management at the University of L'aquila (Central Italy) and the role of students' associations in the April 6th 2009 earthquake', *PLoS Currents*, 9.
- Mahase, E. (2020) 'Coronavirus: Covid-19 has killed more people than SARS and MERS combined, despite lower case fatality rate', 368: m641.
- Maier, K., Berkman, J. and Chatkoff, D. (2012) 'Novel virus, atypical risk group: Understanding young adults in college as an under-protected population during H1N1 2009', *PLoS Currents*, 4.
- Marinoni, G., van't Land, H. and Jensen, T. (2020) 'The impact of Covid-19 on higher education around the world', *IAU Global Survey Report*, International Association of Universities.
- Martin-Martin, A., Orduña-Malea, E., Harzing, A. W. and López-Cózar, E. D. (2017) 'Can we use Google Scholar to identify highly-cited documents?', *Journal of Informetrics* 11(1): 152–163.
- Meyers, J., Logaraj, M., Ramraj, B., Narasimhan, P. and MacIntyre, C. R. (2018) 'Epidemic varicella zoster virus among university students, India', *Emerging Infectious Diseases* 24(2): 366.
- Mitchell, T., Dee, D. L., Phares, C. R., Lipman, H. B., Gould, L. H., Kutty, P. and Siebold, J. (2011) 'Non-pharmaceutical interventions during an outbreak of 2009 pandemic influenza A (H1N1) virus infection at a large public university, April–May 2009', *Clinical Infectious Diseases*, 52(suppl_1): S138–S145.
- Mitchell, T., Massoudi, M., Swerdlow, D. L., Dee, D. L., Gould, L. H., Kutty, P. K. and Fishbein, D. B. (2014) 'Swine flu in college: early campus response to outbreak control measures', *American Journal of Health Behavior* 38(3): 448–464.
- Montgomery, J. M., Woolverton, A., Hedges, S., Pitts, D., Alexander, J., Ijaz, K. and Henao, O. (2019) 'Ten years of global disease detection and counting: program accomplishments and lessons learned in building global health security', *BMC Public Health* 19(Suppl 3): 510.
- Morse, S. S. and Schluederberg, A. (1990) 'Emerging viruses: the evolution of viruses and viral diseases', *The Journal of infectious Diseases* 162(1): 1–7.
- Mounier-Jack, S. and Coker, R. J. (2006) 'How prepared is Europe for pandemic influenza? Analysis of national plans', *The Lancet* 367(9520): 1405–1411.
- Mukhsam, M. H., Jeffree, M. S., Pang, N. T. P., Rahim, S. S. S. A., Omar, A., Abdullah, M. S. and Saupin, S. (2020) 'A university-wide preparedness effort in the alert phase of COVID-19 incorporating community mental health and task-shifting strategies: experience from a Bornean institute of higher learning', *The American Journal of Tropical Medicine and Hygiene* 103(3): 1201–1203.
- New Straits Times. (2020) 'UMK makes PPE and shield visors for Covid-19 frontliners', *New Straits Times*, 30 March.
- New Straits Times. (2020) '40 Malaysian students in Beijing return home', *New Straits Time*, 1 February.
- NewstreamAsia. (2020) *University students on campus are well taken care of during transit*. 1 April, <http://www.newstream.asia/community/university-students-on-campus-are-well-taken-care-of-during-transit/>, accessed 16 September.
- Nordin, R. (2020) 'UTHM Postpones all activities, gatherings after staff member tested positive for Covid-19', *The Star Online*, 15 March, <https://www.thestar.com.my/news/nation/2020/03/15/uthm-postpones-all-activities-gatherings-after-staff-member-tested-positive-for-covid-19>, accessed 30 March.
- Osburn, T. W. (2008). Hazard mitigation and disaster preparedness planning at american coastal university: seeking the disaster-resistant university', PhD Dissertation, University of North Texas.
- Pappas, G., Panagopoulou, P. and Akritidis, N. (2009) 'Reclassifying bioterrorism risk: are we preparing for the proper pathogens?', *Journal of Infection and Public Health* 2(2): 55–61.
- Park, J. H., Cheong, H. K., Son, D. Y., Kim, S. U. and Ha, C. M. (2010) 'Perceptions and behaviors related to hand hygiene for the prevention of H1N1 influenza transmission among Korean university students during the peak pandemic period', *BMC Infectious Diseases* 10(1): 222.

- Park, S. W., Jang, H. W., Choe, Y. H., Lee, K. S., Ahn, Y. C., Chung, M. J. and Han, T. (2016) 'Avoiding student infection during a Middle East respiratory syndrome (MERS) outbreak: a single medical school experience', *Korean Journal of Medical Education* 28(2): 209.
- Phillipson, L., Jones, S. C., Larsen-Truong, K., Robinson, L. and Barrie, L. (2013) 'Using social marketing to promote cold and flu prevention behaviors on an Australian university campus', *Faculty of Social Sciences - Papers*, 1251.
- Phua, K. L. (2015) 'Meeting the challenge of Ebola virus disease in a holistic manner by taking into account socioeconomic and cultural factors: the experience of West Africa', *Infectious Diseases: Research and Treatment*, 8: IDRT-S31568.
- Rafidi, R. (2020). 'Malaysian varsities join Covid-19 testing battle', *New Straits Times*, 8 April.
- Rahman, A. A. (2020) 'UPM Emergency Response Team (ERT-UPM COVID-19) | PUTRA International Centre (i-PUTRA)', *UPM NEWS*, 2 April.
- Rahman, F. (2020) 'The Malaysian response to COVID-19: building preparedness for 'surge capacity', testing efficiency and containment', *European Pharmaceutical Review*, <https://www.europeanpharmaceuticalreview.com/article/125084/the-malaysian-response-to-covid-19-building-preparedness-for-surge-capacity-testing-efficiency-and-containment/>, accessed 10 September.
- Ramsey, M. A. and Marczinski, C. A. (2011) 'College students' perceptions of H1N1 flu risk and attitudes toward vaccination', *Vaccine* 29(44): 7599–7601.
- Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., and Koole, M. (2020) 'Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity', *Postdigital Science and Education*, 1–23.
- Rautiainen, R., Lehtola, M. M., Day, L. M., Schonstein, E., Suutarinen, J., Salminen, S. and Verbeek, J. H. (2008) 'Interventions for preventing injuries in the agricultural industry', *Cochrane Database of Systematic Reviews*, <https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD006398.pub2/full>, accessed 5 August.
- Reperant, L. A. and Osterhaus, A. D. (2017) 'AIDS, Avian flu, SARS, MERS, Ebola, Zika what next?', *Vaccine* 35(35): 4470–4474.
- Riccardo, F., Suk, J. E., Espinosa, L., Bella, A., Giambi, C., Del Manso, M. and Declich, S. (2018) 'Key dimensions for the prevention and control of communicable diseases in institutional settings: a scoping review to guide the development of a tool to strengthen preparedness at migrant holding centres in the EU/EEA', *International Journal of Environmental Research and Public Health* 15(6): 1120.
- Rogers, B. and Lawhorn, E. (2007) 'Disaster preparedness: occupational and environmental health professionals' response to Hurricanes Katrina and Rita,' *AAOHN Journal* 55(5): 197–207.
- Runyan, C. W. (2003) 'Introduction: back to the future—revisiting Haddon's conceptualization of injury epidemiology and prevention', *Epidemiologic Reviews* 25(1): 60–64.
- Ryu, W. S. (2017) *Molecular Virology of Human Pathogenic Viruses*, London: Elsevier.
- Salman, M., Shehzadi, N., Hussain, K., Saleem, F., Khan, M. T., Asif, N. and AbuBakar, U. (2017) 'Knowledge of Ebola virus disease among a university population: a cross-sectional study', *American Journal of Infection Control* 45(2): e23–e25.
- Schlenker, E. H., Tschetter, R. L. and Straub, H. R. (2013) 'Influence of the H1N1 pandemic on university students' knowledge of influenza', *South Dakota Medicine* 66(11): 449–457.
- Seale, H., McLaws, M. L., Van, D., Crimmins, J. and MacIntyre, C. R. (2011) 'University communication strategies during a pandemic—were the messages received?', *Journal of Public Health Management and Practice* 17(1): E29–E32.
- Seale, H., Mak, J. P., Razee, H. and MacIntyre, C. R. (2012) 'Examining the knowledge, attitudes and practices of domestic and international university students towards seasonal and pandemic influenza', *BMC Public Health* 12(1): 307.



- Shah, A. U. M., Safri, S. N. A., Thevadas, R., Noordin, N. K., Abd Rahman, A., Sekawi, Z. and Sultan, M. T. H. (2020). COVID-19 outbreak in Malaysia: actions taken by the Malaysian government. *International Journal of Infectious Diseases* 97: 108–116.
- Shenoy, V., Mahendra, S. and Vijay, N. (2020) 'COVID 19 lockdown technology adaption, teaching, learning, students engagement and faculty experience', *Mukt Shabd Journal* 9(4): 698–702.
- Soto Mas, F., Olivarez, A., Jacobson, H. E., Hsu, C. E. and Miller, J. (2011). Risk communication and college students: The 2009 H1N1 pandemic influenza', *Preventive Medicine: An International Journal Devoted to Practice and Theory* 52(6): 473–474.
- Sundarasan, S., Chinna, K., Kamaludin, K., Nurunnabi, M., Baloch, G. M., Khoshaim, H. B. and Sukayt, A. (2020) 'Psychological impact of Covid-19 and lockdown among university students in Malaysia: implications and policy recommendations', *International Journal of Environmental Research and Public Health* 17(17): 6206.
- Suresh, P. S., Thejaswini, V. and Rajan, T. (2011) 'Factors associated with 2009 pandemic influenza A (H1N1) vaccination acceptance among university students from India during the post-pandemic phase', *BMC Infectious Diseases* 11(1): 205.
- Surgeoner, B. V., Chapman, B. J. and Powell, D. A. (2009) 'University students' hand hygiene practice during a gastrointestinal outbreak in residence: what they say they do and what they actually do', *Journal of Environmental Health* 72(2): 24–29.
- Taskforce, UMK. (2020) *Pelan Respons Dan Kesiapsiagaan Bagi Covid-19 Dan Penyakit Berjangkit Yang Lain*. Kota Bharu. http://www.umk.edu.my/covid19/BOOK_Pelan-RR-COVID-UMK-ver1.pdf, accessed 16 September.
- Taylor, L. H., Latham, S. M. and Woolhouse, M. E. (2001) 'Risk factors for human disease emergence', *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences* 356(1411): 983–989.
- Teng-Teng, B. U. (2015) 'The research on kindergarden security management based on haddon matrix', *Journal of Weifang Engineering Vocational College* (2): 15.
- Tiwari, A., Tarrant, M., Yuen, K. H., Chan, S., Kagan, S., Ching, P. and Wong, S. S. (2006) 'Preparedness for influenza pandemic in Hong Kong nursing units', *Journal of Nursing Scholarship* 38(4): 308–313.
- Tkachuck, M. A., Schulerberg, S. E. and Lair, E. C. (2018) 'Natural disaster preparedness in college students: Implications for institutions of higher learning', *Journal of American College Health* 66(4): 269–279.
- Tork, H. M. and Mersal, F. A. (2018) 'Middle East Respiratory Syndrome-Corona virus: Knowledge and attitude of Qassim University students, KSA', *Global Adv Res J Med Med Sci* 7(4): 90–7.
- Townley, K. F. and McKnight, R. H. (1994) 'Developmentally inappropriate play areas in rural day care: is it safe to play outdoors?', *Pediatrics* 94(6): 1050.
- Uchida, M., Tsukahara, T., Kaneko, M., Washizuka, S. and Kawa, S. (2012) 'How the H1N1 influenza epidemic spread among university students in Japan: experience from Shinshu University', *American Journal of Infection Control* 40(3): 218–220.
- Updegraff, J. A., Emanuel, A. S., Gallagher, K. M. and Steinman, C. T. (2011) 'Framing flu prevention—An experimental field test of signs promoting hand hygiene during the 2009–2010 H1N1 pandemic', *Health Psychology*, 30(3): 295.
- Van, D., McLaws, M. L., Crimmins, J., MacIntyre, C. R. and Seale, H. (2010) 'University life and pandemic influenza: Attitudes and intended behaviour of staff and students towards pandemic (H1N1) 2009', *BMC Public Health* 10(1): 130.
- Varney, S., Hirshon, J. M., Dischinger, P. and Mackenzie, C. (2006) 'Extending injury prevention methodology to chemical terrorism preparedness: the Haddon Matrix and sarin', *American Journal of Disaster Medicine* 1(1): 18–27.
- Virk, R. K., Gunalan, V., Lee, H. K., Inoue, M., Chua, C., Tan, B. H. and Tambyah, P. A. (2017) 'Molecular evidence of transmission of influenza A/H1N1 2009 on a university campus', *PLoS One* 12(1): e0168596.

- Wang, C., Cheng, Z., Yue, X.-G. and McAleer, M. (2020) 'Risk management of COVID-19 by universities in China', *J. Risk Financial Manag.* 13: 36.
- Wendelboe, A. M., Amanda Miller, J. D., Drevets, D., Salinas, L., Miller, E. J., Jackson, D. and Public Health Working Group. (2020) 'Tabletop exercise to prepare institutions of higher education for an outbreak of COVID-19', *Journal of Emergency Management* 18(2): 1–20.
- Wilson, S. and Huttlinger, K. (2010) 'Pandemic flu knowledge among dormitory housed university students: a need for informal social support and social networking strategies', *Rural and Remote Health* 10(4): 1–9.
- Wilson, M. G., Lavis, J. N. and Guta A. (2012a) "Community-Based Organizations in the Health Sector: A Scoping Review." *Health Research Policy and Systems.*
- Wilson, M. G., Lavis, J. N. and Guta, A. (2012b) 'Community-based organizations in the health sector: a scoping review', *Health Research Policy and Systems* 10(1): 36.
- Wong, J. G., Cheung, E. P., Cheung, V., Cheung, C., Chan, M. T., Chua, S. E. and Ip, M. S. (2004) 'Psychological responses to the SARS outbreak in healthcare students in Hong Kong', *Medical Teacher* 26(7): 657–659.
- Wong, T. W., Gao, Y. and Tam, W. W. S. (2007) 'Anxiety among university students during the SARS epidemic in Hong Kong', *Stress and Health: Journal of the International Society for the Investigation of Stress* 23(1): 31–35.
- World Health Organization. (2004) 'Informal consultation on influenza pandemic preparedness in countries with limited resources', Kuala Lumpur, Malaysia, 23-25 June, Department of Communicable Disease Surveillance and Response, Geneva.
- Xu, J., Zheng, Y., Wang, M., Zhao, J., Zhan, Q., Fu, M. and Cheng, Y. (2011) 'Predictors of symptoms of posttraumatic stress in Chinese university students during the 2009 H1N1 influenza pandemic', *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research* 17(7): PH60.
- Yan, T. C. and Yu, M. (2019) 'Using the Haddon matrix to explore medical response strategies for terrorist subway bombings', *Military Medical Research* 6(1): 4.
- Yang, S. and Cho, S. I. (2017). 'Middle East respiratory syndrome risk perception among students at a university in South Korea, 2015', *American Journal of Infection Control* 45(6): e53–e60.
- Ye-hua, S. (2006) 'The discussion of the Haddon Matrix to public health emergency readiness and response', *Chinese Journal of Disease Control and Prevention*, http://en.cnki.com.cn/Article_en/CJFDTotal-JBKZ200606017.htm, accessed 7 July 2020.
- Zhang, Y. Z., Dong, X., Li, X., Ma, C., Xiong, H. P., Yan, G. J. and Zou, Y. (2009) 'Seoul virus and hantavirus disease, Shenyang, People's Republic of China', *Emerging Infectious Diseases* 15(2): 200.
- Zhong, S., Clark, M., Hou, X. Y., Zang, Y. L. and FitzGerald, G. (2013) '2010–2011 Queensland floods: Using Haddon's Matrix to define and categorise public safety strategies', *Emergency Medicine Australasia* 25(4): 345–352.
- Zhong, S., Clark, M., Hou, X. Y., Zang, Y. and FitzGerald, G. (2014) 'Progress and challenges of disaster health management in China: a scoping review', *Global Health Action* 7(1): 24986.

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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	
					Administrative	Teaching	Research		
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 <i>et al.</i> (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	Wong <i>et al.</i> (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	-	-	-	Stress management needed to reduce depression and anxiety. should be provided to all students as a preventive measure during future outbreaks	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 <i>et al.</i> (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 distance 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 <i>et al.</i> (2007)

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference
					Administrative	Teaching	Research	
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 Seale <i>et al.</i> (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 <i>et al.</i> (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 <i>et al.</i> (2010)



continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference
					Administrative	Teaching	Research	
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 <i>et al.</i> (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 <i>et al.</i> (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 <i>et al.</i> (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 <i>et al.</i> (2014)

<i>continued</i>	<i>No.</i>	<i>Disease year of study</i>	<i>Country</i>	<i>Study sample</i>	<i>Theme of study</i>	<i>Findings/recommendations for planning and preparedness</i>				<i>Reference</i>
						<i>Administrative</i>	<i>Teaching</i>	<i>Research</i>	<i>Students Affairs</i>	
	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)

continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference
					Administrative	Teaching	Research	
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	-	1. Need to promote positive public health behaviours 2. Provide extra hand-washing facilities and posters encouraging compliance in communal areas and computer labs 3. Boost hygienic practices by openly distributing small bottles of hand gel or tissue packets to staff and students on campus	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)



<i>No.</i>	<i>Disease year of study</i>	<i>Country</i>	<i>Study sample</i>	<i>Theme of study</i>	<i>Findings/recommendations for planning and preparedness</i>			<i>Reference</i>
					<i>Administrative</i>	<i>Teaching</i>	<i>Research</i>	
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 intention with respect to H1N1	-	-	-	Soto Mas <i>et al.</i> (2011)
20	H1N1 2011	USA	514 students	Assessed attitudes towards vaccination	-	-	-	Ramsey and Marczinski (2011)

continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference	
					Administrative	Teaching	Research		
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 <i>et al.</i> (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	Seale <i>et al.</i> (2011)



continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference
					Administrative	Teaching	Research	
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	-	-	Time for evacuation of the dorms may have a significant impact on the number of infections and mortalities	Araz <i>et al.</i> (2011)
24	H1N1 2011	Egypt	1312 students	Assess the knowledge, attitudes and practices of E1-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 <i>et al.</i> (2012)

continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference
					Administrative	Teaching	Research	
26	H1N1 2012	Japan	11,424 students	Disease transmission among students at Shinsyu University	-	-	-	Main transmission route was associated with club activity <i>Uchida et al. (2012)</i>
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	-	-	<i>Schlenker et al. (2013)</i>
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 <i>Greenland et al. (2012)</i>
29	Measles 2014	Korea	1691 staff and students	Estimate vaccine effectiveness	-	-	-	Under-immunity among young adult population needs to be improved <i>Choe (2017)</i>

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference
					Administrative	Teaching	Research	
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 <i>et al.</i> (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 <i>et al.</i> (2014)					

continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference	
					Administrative	Teaching	Research		Students Affairs
32	Disaster Plans and Emergency Preparedness	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)	
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	-	-	-	Erokiidem et al. (2018)



continued

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	<ol style="list-style-type: none"> 1. Immediate school closure 2. Open communication with faculty and staff 	<ol style="list-style-type: none"> 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 <i>et al.</i> (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-Muhafida <i>et al.</i> (2016)

continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference		
					Administrative	Teaching	Research		Students Affairs	
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 on-campus interventions such as quarantine of hostels, cancellation of lectures, and shut-down of canteen areas	-	-	-	Virk <i>et al.</i> (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	
40	H1N1 2017	Salman <i>et al.</i> (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 <i>et al.</i> (2017)

continued

No.	Disease year of study	Country	Study sample	Theme of study	Findings/recommendations for planning and preparedness			Reference	
					Administrative	Teaching	Research		
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 1. Females had better knowledge than males 2. Medical students are more knowledgeable than non-medical students	Meyers <i>et al.</i> (2018)
42	MERS 2018	Saudi Arabia	733 students	Knowledge and attitude were assessed	-	-	-	Tork and Mersal (2018)	

Italic rows denote studies reporting outbreaks occurring on IHE campuses.