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Literature Review

Emerging and Re-emerging Infectious Diseases in the WHO Eastern Mediterranean Region, 2001-2018

Ehsan Mostafavi[1*], Abdolmajid Ghasemian[1], Abubakar Abdinasir[2], Seyed Alireza Nematollahi Mahani[1], Salman Rawaf[3], Mostafa Salehi Vaziri[4], Mohammad Mahdi Gouya[5], Tran Minh Nhu Nguyen[2], Salah Al Awaidy[6], Lubna Al Ariqi[2], Md. Mazharul Islam[7,8], Elmoubasher Abu Baker Abd Farag[9], Majdouline Obtel[10,11], Peter Omondi Mala[2], Ghassan M. Matar[12], Rana Jawad Asghar[13,14], Amal Barakat[2], Mohammad Nadir Sahak[15], Mariam Abdulmonem Mansouri[16,17], Alexandra Swaka[3]

Abstract

Background: Countries in the World Health Organization (WHO) Eastern Mediterranean Region (EMR) are predisposed to highly contagious, severe and fatal, emerging infectious diseases (EIDs), and re-emerging infectious diseases (RIDs). This paper reviews the epidemiological situation of EIDs and RIDs of global concern in the EMR between 2001 and 2018.

Methods: To do a narrative review, a complete list of studies in the field was we prepared following a systematic search approach. Studies that were purposively reviewed were identified to summarize the epidemiological situation of each targeted disease. A comprehensive search of all published studies on EIDs and RIDs between 2001 and 2018 was carried out through search engines including Medline, Web of Science, Scopus, Google Scholar, and ScienceDirect.

Results: Leishmaniasis, hepatitis A virus (HAV) and hepatitis E virus (HEV) are reported from all countries in the region. Chikungunya, Crimean Congo hemorrhagic fever (CCHF), dengue fever, and H5N1 have been increasing in number, frequency, and expanding in their geographic distribution. Middle East respiratory syndrome (MERS), which was reported in this region in 2012 is still a public health concern. There are challenges to control cholera, diphtheria, leishmaniasis, measles, and poliomyelitis in some of the countries. Moreover, Alkhurma hemorrhagic fever (AHF), and Rift Valley fever (RVF) are limited to some countries in the region. Also, there is little information about the real situation of the plague, Q fever, and tularemia.

Conclusion: EIDs and RIDs are prevalent in most countries in the region and could further spread within the region. It is crucial to improve regional capacities and capabilities in preventing and responding to disease outbreaks with adequate resources and expertise.

Keywords: Neglected Tropical Diseases, Emerging Infectious Diseases, Zoonosis, MERS-CoV, CCHF, Eastern Mediterranean Region

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***Correspondence to:**
Ehsan Mostafavi
Email: mostafavi@pasteur.ac.ir

Introduction

Emerging infectious diseases (EIDs) are those that have recently appeared within a population or those whose incidence or geographic range is rapidly increasing or threatens to increase shortly. Re-emerging infectious diseases (RIDs) are those which were previously controlled, but have again risen to be a significant health threat.[1,2] The emergence of high-threat pathogenic diseases has increased in recent years globally.[2] Almost 75% of recently emerged diseases afflicting humans have a zoonotic origin.[2]

Many countries in the World Health Organization (WHO) Eastern Mediterranean Region (EMR) are affected directly or indirectly by acute and protracted humanitarian emergencies, which have led to an unusually high number of internally displaced people and refugees living in overcrowded, overburdened camps, with little or no access to basic social and healthcare services.[3] Many factors are contributing to the emergence or re-emergence of high-threat pathogenic diseases including pathogen's adaptation or resistance, host behavior such as migration, international travel, human-animal interaction, poverty, climate change, and industrial and economic development.[4]

WHO EMR includes countries from North Africa to southwest Asia, with a total population of 670 million, Pakistan, Egypt, and Iran with about 200, 105, and 85 million people are respectively the most populated countries in this region.[5]

EIDs and RIDs occur as a result of interconnection among social, economic, biological, technological, and ecological factors. A high percentage of EMR populations live in poverty with the regional average gross domestic product per capita lagging behind the global average,[6] with significance in Somalia, Afghanistan, Yemen, Syria, and Sudan[7]; thus, further predisposing the region to EIDs and RIDs. Different

Full list of authors' affiliations is available at the end of the article.

climate and living conditions lead to the spread of various diseases,[8] with ecological changes playing an important role in the re-emergence of infectious diseases.[9] The periodic mass gathering of pilgrims in the EMR, namely to Saudi Arabia and Iraq, can also be a threat for outbreaks of EIDs and RIDs.[10] Increased conflict and political instability in the region that lead to large population movement are other major causes of elevating the risk of spreading various diseases (eg, diphtheria, cholera, and leishmaniasis).[11]

Recent outbreaks of EIDs and RIDs in the EMR include Crimean Congo hemorrhagic fever (CCHF) in Afghanistan[12], chikungunya in Pakistan and Sudan,[13,14] cholera in Somalia, and Yemen,[15] diphtheria in Pakistan and Yemen,[16,17] influenza H5N1 in Egypt,[18] leishmaniasis in Pakistan, Syria and Afghanistan,[19-21] measles in Pakistan and Afghanistan,[16,22] Middle East respiratory syndrome (MERS) in Arabian Peninsula,[23-25] plague in Afghanistan,[26] polio in Afghanistan and Pakistan,[27,28] and Q fever in Afghanistan and Iraq.[29,30] The magnitude of many of EIDs and RIDs has not been currently verified in some EMR countries. The first step in forecasting, preparing, and control of these diseases is to ascertain its existence and frequency. This paper aims to review the epidemiological situation of the EIDs and RIDs in the EMR between 2001 and 2018.

Methods

This paper is a narrative review. An exhaustive list of emerging and RIDs was identified through a literature search. The preliminary list was then shared with EMR 17 experts using Delphi method. The experts covered a range of specialities, including microbiology, epidemiology, and clinical infectious disease. Based on the expert's opinion, a final list of infectious diseases of global concern in EMR was identified and approved.

A review about the epidemiological situation of the EIDs and RIDs in the EMR was conducted. A complete list of studies in the field was prepared following a systematic search approach. Studies that were purposively reviewed were identified to summarize the epidemiological situation of each targeted infectious disease in different EMR countries. Accessible electronic and hand-search of grey literature across all countries of the region were searched.

Systematic Search of Literature

Electronic databases were carefully searched using Medical Subject Headings terms and keywords, by the name of each of the targeted diseases or their causative agent and the name of each country in the region to extract the diseases reported between 2001 and 2018. The extensive databases included: Google Scholar, Midline, Web of Science, ScienceDirect, Scopus, Medline. We also searched grey literature via a general internet search, Web of Science, Weekly Epidemiological Monitor, WHO/EMRO, situation updates, annual reports, and report publications by the WHO, the official WHO website, and ProMED. The reference lists of all relevant articles were hand-searched to identify further any additional studies that may not have been captured by extensive searches.

Screening of Potentially Relevant Citation

Two investigators assessed titles and abstracts for relevance to the key questions using prespecified inclusion and exclusion criteria. Full-text articles identified by either investigator as potentially relevant were retrieved for further review and examined by two investigators independently.

All outcomes were adequately covered in the EndNote® reference management software (version X5, Thomson Reuters, Philadelphia, PA, USA).

Inclusion Criteria

Eligible subjects invariably had to satisfy the following inclusion criteria sufficiently including, study designs: Published papers from 2001 and 2018 that reported the epidemiological situation of the targeted diseases in the region were included. The ultimate goal was to typically identify related systematic reviews, review articles, case reports and original articles and it was limited to Arabic and English language publications.

Quality Assessment

A narrative review was based on high-quality evidence. The methodological quality of studies that were a candidate for data extraction for this narrative review was subjectively appraised by two investigators, considering the following criteria: (*a*) No evidence of selection bias, (*b*) Proper sample size, and (*c*) Negligible publication bias (for systematic reviews).

Disagreements were resolved between the two investigators by discussion. A flowchart of the study selection process is illustrated in Figure 1.

Data Abstraction and Analysis

Extracted data were abstracted into a customized Excel spreadsheet, extensive database by one investigator and verified by a second investigator. All related papers found were carefully reviewed and succinctly summarized for potential inclusion in this report. The included diseases are listed in three groups (viral, bacterial, and parasitic EIDs and RIDs) alphabetically by common name.

Results

Viral Emerging and Re-emerging Infectious Diseases

Acute hepatitis A and E: Except for a few published articles and outbreak reports, very limited data are available about the prevalence of hepatitis A virus (HAV) and hepatitis E virus (HEV) from countries in the EMR.[31] HAV and HEV are reported in high frequency in some studies in Tunisia (84%),[32] Yemen (86%),[33] Iran (86%), Iraq (96%),[34] Egypt (100%),[35] and Libya (100%).[36] Morocco is an intermediate endemic area for the HAV infection.[37] Most rural areas have high anti-HAV antibody prevalence due to consumption of sewage-contaminated water and use of indoor dry pits.[38] Several outbreaks of HAV infection have erupted among tourists from European countries.[39] There were major HAV outbreaks in Syria and Lebanon in 2013 and 2014, concurrent with the Syrian crisis and influx of refugees.[40,41]

In Iran, the frequency of HEV varied from 2.3% to over 40%,[42] and have reported 20% in United Arab Emirates (UAE)

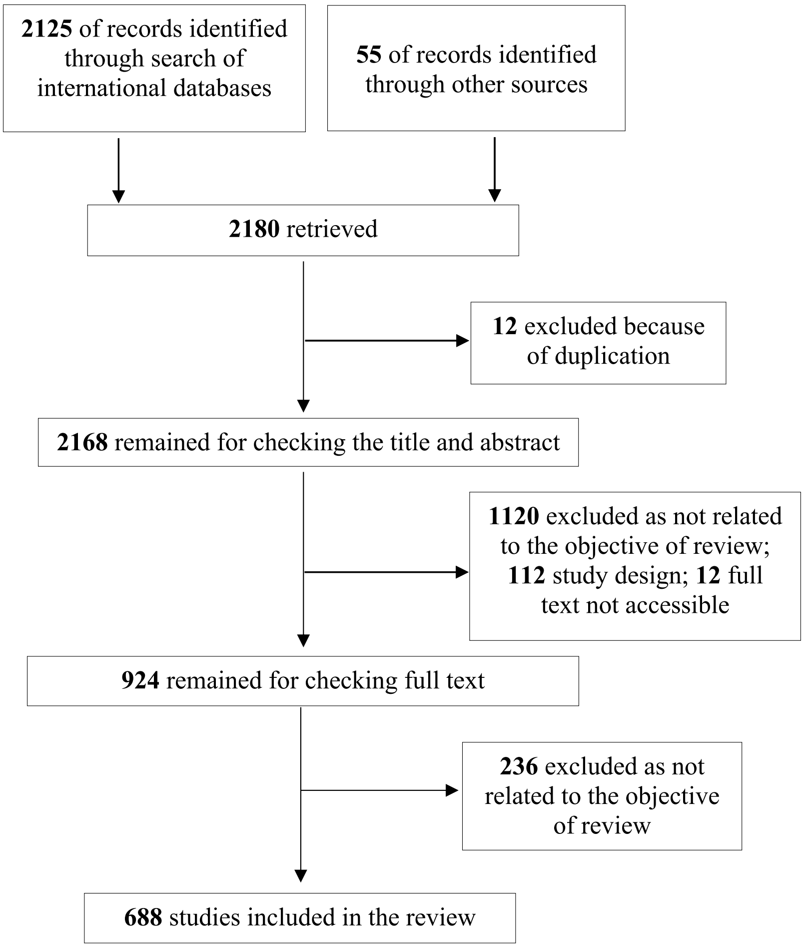

Figure 1. A Flow Chart Depicts the Stages of Retrieving References, Checking Eligibility Criteria, and Including the Final Articles Into The Review.

in mothers,[43] 19.4% in Iraq in blood donors,[34] 13% in Egypt in workers,[44] 10% in Yemen,[33] 3% in Pakistan,[45] and 0.3% in Saudi Arabia.[46] According to reports from Pakistan, HAV and HEV are responsible for more than 19% and 12% of all newly diagnosed cases of viral hepatitis, respectively.[31]

Alkhurma hemorrhagic fever (AHF): AHF is a zoonotic viral disease that emerged in 1995 in Saudi Arabia.[47] In the initial stages of the disease discovery, high mortality rates of up to 25% were reported.[48] As the disease became better known and recognizable, identification of subclinical infections lowered the mortality rates to about 1.3%.[49] There is still a knowledge gap regarding the transmission pathways of the disease.[50]

AHF has been reported from Saudi Arabia and Egypt.[51,52] Seropositive cases and AHF virus-infected *Amblyomma lepidum* ticks have been reported in Djibouti.[53]

Avian influenza (H5N1): The virus was reported in 16 countries and is expected to expand its range further. In 2006, H5N1 spread rapidly through the EMR with large non-human (mostly avian) outbreaks in Afghanistan, Djibouti, Egypt, Iran, Iraq, Jordan, occupied Palestinian territories, Pakistan, and Sudan. Since then the H5N1 has become endemic in Egyptian poultry.[54] The circulation of the virus was confirmed in Saudi Arabia, Egypt, and Libya.[55,56] Since 2006, Human cases of H5N1 were reported only from Egypt, Iraq, Djibouti, and Pakistan.[57] However, Egypt has been the most affected country in the region where the disease has remained endemic, with frequent epizootic cases in addition to 356 reported human cases, including 121 deaths since October 2016, the highest number of H5N1 human cases (42%, 356/854) in the world.[58,59] A recent analysis demonstrated that the most important environmental predictors for the spread of the disease in the Middle East are the environmental temperature during the warmest quarter in correlation with high transmission rates within the livestock system with Egypt, Kuwait, Saudi Arabia, and Sudan.[60] While nearly all cases in EMR have been associated with contact with infected birds, human-to-human transmission of H5N1 has also been indicated in Djibouti, Iraq, and Pakistan, but limited.[61]

Chikungunya: Outbreaks of Chikungunya have only been documented in Djibouti, Pakistan, Saudi Arabia, Somalia, Sudan, and Yemen. Imported cases are also reported from Oman.[14,62] Nevertheless, serological studies in other countries such as Egypt, Iraq, Iran, and Kuwait, have reported seropositivity cases.[63] The earliest description of the disease in the EMR goes back to 1658 in Egypt. However, the disease presence was confirmed in 2011 in Yemen after a major outbreak with over 15 000 suspected cases.[64]

Similarly, in Pakistan, the serological evidence of disease was first identified in 1983, but no further cases had been identified until 2011. Since then, the total number of infected cases drastically increased to 8330 reported cases in 2017 compared to 405 cases found in the previous year.[65,66] Considering the presence of the competent vectors and international travel of viremic patients between Eastern Mediterranean countries, there seems to be a hidden crisis with a high possibility of transmission and spread of the disease into neighboring chikungunya virus-free countries.[63]

CCHF: So far, human cases of CCHF have been reported from 10 out of 22 countries in EM region including Afghanistan, Iran, Iraq, Oman, Pakistan, Palestine, Saudi Arabia, Sudan, Tunisia, and UAE.[67-70] Iran, Pakistan, and Afghanistan are countries reporting 50 or more CCHF cases per year.[71-73] The CCHF virus genome has been identified in ticks in Morocco and Syria.[74,75] Moreover, serological studies of livestock have identified the disease in Egypt and Somalia.[67] In Oman, from 2011-2017, the CCHF patients has steadily increased, the highest cases were reported in 2015.[76]

Dengue: There is limited information about the situation of the disease in EMR. Outbreaks of dengue have occurred in Djibouti, Oman, Pakistan, Saudi Arabia, Somalia, Sudan, Yemen, and Egypt.[77-79] Additionally, serological investigations have shown seroprevalence of dengue in Afghanistan, Iran, Kuwait, Lebanon, Qatar, and Syria.[80] The main mosquito vectors for dengue virus, *Aedes aegypti* and *Aedes albopictus*, have been reported from 15 countries in the region including Afghanistan, Djibouti, Egypt, Iran, Jordan, Lebanon, Oman, Pakistan, Palestine, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, and Yemen.[81-84] However, little is known about the presence of infected vectors in other EM countries, due to the inadequate entomological surveillance systems in most of these countries. In 2017, Pakistan, Egypt, and Sudan reported 125 316, 245, and 139 dengue cases, respectively.[66]

A total of 6777 suspected dengue cases were reported in 2015 in Yemen after the civil war, which began in 2015, causing widespread destruction of the infrastructure and therefore enabling dengue to become endemic in this country.[85]

Measles: In 1997, all EMR countries adopted a resolution to eliminate measles by 2010. This effort resulted in a 93% reduction in mortality from measles between 2000 and 2008. Despite significant progress, the goal was not reached by 2010, and the date was revised to 2015 and then again to 2020.[86] Unlike the predictions, the total number of measles cases increased from over 12 000 cases in 2008 to over 36 000 in 2012.[87] Between 2013 and 2018, 144 966 cases of Measles were reported in the region.[88] All countries in the region have moved to case-based measles surveillance with laboratory confirmation implementing nationwide surveillance and two countries (Somalia and Sudan) implementing sentinel surveillance. Countries affected by war, such as Syria, Yemen, Iraq, Afghanistan, and Lebanon reported high numbers of measles cases, for example during 2013-2016, 7000 cases of measles were reported in Syria, and 5773 cases were reported from Yemen during 2012-2017.[89-91] Pakistan also reported a high number of measles patients due to low vaccination coverage.[92] Djibouti, Somalia, and Sudan are also countries in the region with high incidence.[87] Bahrain, Egypt, Iran, Jordan, Morocco, Palestine, and Tunisia have progressed drastically and reported a very low incidence of endemic measles.[93] Nevertheless, the surge of disease in countries affected by armed conflicts and political instability shows how easily it can return, especially with the low immunization coverage.

MERS: MERS was first reported in Saudi Arabia in 2012.[94] In EMR, 12 countries (Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Tunisia, UAE, and Yemen) have reported cases of MERS.[95-98] By the end of 2018, a total of 2279 confirmed cases were reported globally with the majority of cases in Saudi Arabia (1901 laboratory-confirmed cases, including 732 related deaths with a case–fatality ratio of 38.5%).[99] Most of the primary MERS cases outside Arabian Peninsula were linked with either by travel or residence in the countries of Arabian Peninsula.[100] Transboundary movement of humans and camels among the Arab countries could be a source of MERS coronavirus (MERS-CoV) transmission.[101] Clusters of MERS secondary cases were reported either in hospital or family settings in Saudi Arabia, UAE, and Iran.[102-104] In Saudi Arabia, hospital outbreaks in 2015-2018 resulted in 334 cases and 102 associated deaths, and approximately 30% of these reported cases were healthcare workers.[105] In Qatar, MERS pattern were mostly sporadic within the primary cases. It may be due to Qatar One Health approach to challenge MERS-CoV, and infection protection and control system in healthcare settings.[106]

Egypt, Qatar, UAE, Oman, Morocco, and Sudan, among other countries within the EM region carried out surveillance studies on dromedary camels. Results obtained revealed high seropositivity in Egypt (84.5%) and Qatar (59% and 79%); besides, MERS-CoV genetic material was identified in 6.57%, 3.8%, and 1.6% of sampled camels from Oman, Egypt and UAE, respectively.[25,107-112]

Rabies: Currently, zoonotic rabies remains mostly in dogs as the principal reservoir in the Middle East.[113] Incidence from foxes was reported in UAE and Oman, and from wolves in Syria.[114] Rabies is reported endemic in Egypt, Iran, Iraq, Pakistan, Sudan, Tunisia, Morocco, Syria, Yemen, Jordan, Oman, Palestine, Lebanon, and Saudi Arabia.[115,116] The UAE, Bahrain, and Kuwait are the only countries in the region that are considered rabies-free.[115] Libya, Somalia, and Djibouti have no information available about rabies in humans or animals.[116] The disease rate in animals has sharply increased in Lebanon from 2010-2016 coinciding with the beginning of Syrian conflict.[117]

Rift Valley fever (RVF): Outbreaks of RVF have been documented in the Arabian Peninsula in Yemen and Saudi Arabia (2000, 516 cases with 87 deaths),[118-120] Egypt (2003, 148 cases with 27 deaths), Somalia (2006-2007, 114 cases with 51 deaths) and Sudan (2007-2008, 738 cases with 230 deaths).[121,122] In 2017, seropositive livestock was reported in western Iran.[123] With the virus showing high competence for a wide range of mosquitoes, the WHO predicts future outbreaks in Egypt, Sudan, Morocco, Saudi Arabia, and Yemen.[124]

Sandfly fever: Although research has demonstrated the circulation of sandfly virus in Afghanistan, Egypt, Iran, Iraq, Morocco, Pakistan, Palestine, Tunisia, Saudi Arabia, Somalia, and Sudan,[125-127] little is known about the epidemiology of sandfly fever in the EMR. Dashli virus belonging to the

Sicilian serogroup and two cases of severe encephalitis caused by sandfly fever virus were reported from Iran and occupied Palestine.[128-130] Furthermore, antibodies against sandfly fever virus have been detected in Iran.[131] In 2010-2011, a serological investigation in Djibouti indicated the circulation of Toscana-related viruses.[132] In 2007, an outbreak of sandfly fever was reported from Lebanon with 700 cases.[133] In 2017, cases were also reported from Afghanistan.[125]

West Nile fever (WNF): Human seropositive cases of WNF have been reported in Afghanistan, Djibouti, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Pakistan, Sudan, Tunisia, and Yemen.[134] WNF infection in Culex mosquitoes was demonstrated in Djibouti, Egypt, Iran, and Tunisia.[134] This indicates the widespread circulation of WNF virus in the EMR and underlines the requirement for integrated surveillance programs. In 2018, an outbreak of WNF with 377 suspected cases, out of which 49 cases were laboratory-confirmed, was reported from Tunisia.[135]

Poliomyelitis: In April 2013, a case of wild poliovirus was detected in Somalia, which quickly spread, affecting 194 people by the end of 2013. The long-term political instability in Iraq and Syria means they are key at-risk countries for re-emergence of polio.[136] Syria had a disease outbreak in 2014 that was closely associated with the virus originating from Pakistan. In 2017, Syria was affected by circulating vaccine-derived poliovirus.[137] The last reported polio cases in Somalia were five new cases in 2014.[138] In 2017, 22 cases of wild poliovirus were found in Afghanistan and Pakistan, of which increased to 33 cases in 2018.[28,66] Today the disease is only seen in Afghanistan, Pakistan, and Nigeria where vaccination was not fully covered.[139] As the virus remains present in the EMR, all countries in the region are still at high risk for re-emergence of the disease.

Bacterial Emerging and Re-emerging Infectious Diseases

Cholera: Cholera is a disease resulting from poor sanitation and living conditions. The disease is widespread across the EMR. Between 2010 and 2016, Iran, Afghanistan, Pakistan, Yemen, Iraq, and Somalia reported the disease.[140-142] In 2017, the largest outbreak of cholera in regional history was witnessed in Yemen with 1.3 million cases, and over 2500 deaths were reported by the end of 2018.[143] The second most affected country in the EMR is Somalia reporting 75 414 cases and 1007 associated deaths since the outbreak started in 2017. Other countries in the region that reported imported cases of cholera in 2017 were Qatar (5), Saudi Arabia (5), UAE (12), and Iran (625).[144] There are concerns about the rise of antibiotic resistance against cholera, due to mobile genetic elements in Yemen.[145]

Diphtheria: Pakistan (930 cases), Iran (631 cases), and Sudan (225 cases) are among the list of countries with the highest prevalence of diphtheria between 2010 and 2017.[146,147] Between 2001 and 2018, cases of diphtheria are also reported to the WHO from Afghanistan, Iraq, Lebanon, Qatar, Saudi Arabia, Somalia, and Yemen,[17] and no cases of diphtheria were reported from Bahrain, Djibouti, Egypt, UAE, Jordan, Kuwait, Morocco, Oman, and Tunisia.[147] Furthermore, countries such as Libya and Syria, which have been involved in civil wars, have not been evaluated for disease presence. In Yemen, due to ongoing war resulting in disruption of the healthcare system and lower vaccination coverage, a total of 2609 cases of the disease were reported by the end of 2018,[17] even though the last outbreak in Yemen was in 1982. These outbreaks represent the great potential of diphtheria to re-emerge in disease-free areas and become endemic.[146]

Meningococcal meningitis: The majority of the cases of meningococcal meningitis occur in sub-Saharan African countries. In EMR, Sudan is the only country at high risk of the disease; however, other countries, mainly North African countries, are also at risk.[148] Sudan has received a high burden of disease, experiencing several large outbreaks in 2013.[148,149] In 2016, the meningitis A vaccination was introduced into Sudan's routine immunization program.[150] In 2017, an outbreak of meningitis was reported in Yemen with 2982 cases and 37 deaths.[66]

Although meningococcal meningitis remains an important cause of endemic and epidemic disease across the region, published epidemiological data is fragmented and limited, and the use of vaccines has helped minimize the prevalence of meningococcal meningitis.[151,152] The meningitis belt is highly connected by Muslim pilgrims taking part in the annual Hajj ceremony, gathering in Saudi Arabia, as the congestion of people promotes increased carrier rates of meningitis.[148] The Global Meningococcal Initiative has recommended that EMR countries should mandate vaccination; especially those in which the Hajj is obligatory.

Plague: An outbreak of plague was reported in Afghanistan in 2007, and 17 out of 83 presumed cases became fatal.[26] In 2009, 3 cases of plague were reported from Libya after 25 years of disease absence.[153] Two outbreaks occurred in the years 2009 and 2011 in a coastal town in Libya.[154,155] Western Iran has remained as endemic areas for the plague. A study in 2011 in this region detected *Yersinia pestis* in 1.02% of trapped rodents and 3.42% of dogs.[156] The circulation of plague among domestic and wild animals in the region indicates possible re-emergence of human plague outbreaks.[157]

Q Fever: All countries in the region have detected the disease in humans except Bahrain, Djibouti, Palestine, and UAE.[30,158-163] There was an outbreak of the disease among US military soldiers in Western Iraq in 2005.[29] A similar outbreak was reported among British soldiers in Afghanistan in 2008.[160] A systematic review reported 19% of Q fever seroprevalence in North Africa.[162]

Tularemia: Most of the EMR countries have not reported the disease in recent years due to lack of laboratory facilities and healthcare workers' suboptimal awareness of the disease.[164,165] Iran is the only country in the region, reporting the disease and contaminated water is the main source of infection.[164,166] However, studies on rodents and hares in Iran,[167] on ticks in Yemen,[168] and ticks and abattoir workers in Egypt found samples positive for *Francisella tularensis.*[169]

Parasitic Emerging and Re-emerging Infectious Diseases

Leishmaniasis: All EM countries are reporting the cutaneous and mucocutaneous forms, though the visceral form has limited reports in this region.[170] Six of the ten countries with the highest reported cutaneous leishmaniasis in the world are located in the EMR including Syria, Afghanistan, Iraq, Iran and Pakistan, and Tunisia.[171] The incidence of leishmaniasis has generally decreased in EMR; however, this region still accounts for 70% of all leishmaniasis cases across the world.[172] The zoonotic form of visceral leishmaniasis is endemic in Iran.[173] In Iraq, most leishmaniasis cases are wet type cutaneous form.[174] Studies in Yemen have found *Leishmania tropica* as the main causative agent of leishmaniasis.[175] *Leishmania tropica* is more prevalent in Morocco with a rate of 30%-40% in several districts.[176] In 2016 and 2017, outbreaks of leishmaniasis were reported in Pakistan.[177] In 2017 in a study in Saudi Arabia, 8.3% of studied individuals were positive for cutaneous leishmaniasis.[178]

In recent years, the incidence of cutaneous leishmaniasis has increased in Syria.[179,180] Lebanon, Iraq, and Egypt are affected due to Syrian refugee migration. *Leishmania tropica* is detected in 85% of the Syrian refugee patients in Lebanon.[11] Eastern Libya, similar to Syria and Yemen, has reported the outbreaks of cutaneous leishmaniasis.[181,182]

Discussion

EMR is a hotspot for EIDs and RIDs. Although it's difficult to compare the extend and burden of EID and RIDs in this region with other regions, the number of outbreaks caused by emerging and re-emerging infectious pathogens has increased in the past two decades in this region, greatly affecting social and economic development. The region is especially susceptible to outbreaks of these high-threat pathogens due to the presence of various humanitarian emergencies, fragile health systems, internal conflicts, lack of accurate data, fragile ecosystems, and increased population movement. In recent years, the frequency, duration, and scale of disease outbreaks have escalated for most of these diseases. Many disease outbreaks have been detected and managed in the region such as MERS in the Arabian Peninsula, cholera in Iraq, Somalia and Yemen, Avian influenza A (H5N1) in Egypt, CCHF in Afghanistan, Iran and Pakistan, and dengue fever in Yemen, Sudan and Pakistan (Figure 2, and Table 1). There is a need for a better understanding of disease transmission, preparedness for disease emergence, detection of pathogens and vectors, and implementation of high-impact control and interventions for prevention. This is especially difficult considering the weak surveillance systems of many countries due to limited diagnostic capacities and human resources. Extensive training programs on disease surveillance and response to health emergencies are needed now more than ever in this region.

National efforts for forecasting and controling EIDs/RIDs in the EM region, need to be complemented by regional approaches. Population movements are among the most important factors that need to be considered when forecasting and controlling EIDs or RIDs. Most of the EIDs and RIDs mentioned in this study are potentially transmissible during religious pilgrimages where people from across the world gather in Saudi Arabia and Iraq during Hajj and Arba'een, subsequently travelling back to their home countries. Likewise, refugees and displaced persons primarily from Iraq, Afghanistan, Syria, and Yemen have been living under fragile health systems that are unable to detect many of the referenced infectious diseases, or even if detected, do not have the resources to control and/or provide treatment. As a result, when refugees from these countries migrate, various diseases inevitably spread across large regions.

Disasters and wars are further considerations in predicting and monitoring EIDs or RIDs. The ongoing wars in Iraq, Syria, and Yemen have resulted in poor healthcare systems, where previous infrastructures acting as barriers between people and infectious agents have been devastated and therefore contributed to spreading of several diseases. Especially prevalent are food, waterborne, and vector-borne diseases such as cholera, typhoid, dengue fever, leishmaniasis, and plague. As an example, the civil war in Yemen started in March 2015 and has caused more than 2.2 million people to live in shelters with inadequate healthcare services. The damaged infrastructure and poor water and hygiene in the country have created ideal environmental conditions for the spread of infectious diseases leading to an outbreak of dengue fever[85] and the largest outbreak of cholera in history.[187]

Several zoonotic diseases, including MERS, tularemia, Q

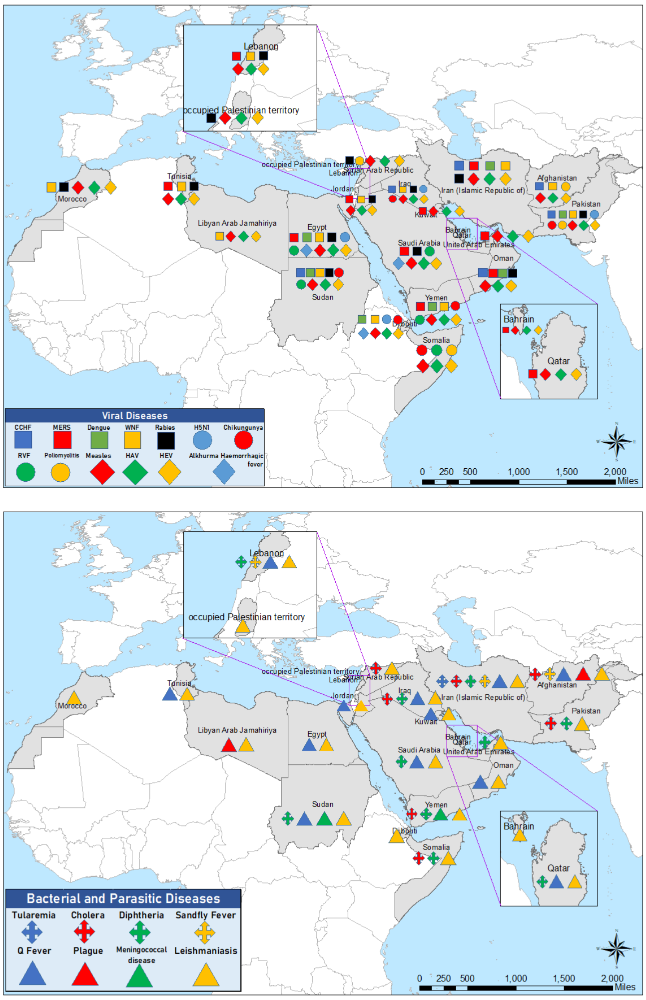

Figure 2. EIDs in Humans Reported in the EMR, 2001-2018. Abbreviations: EMR, Eastern Mediterranean Region; EIDs, emerging infectious diseases. Abbreviations: CCHF, Crimean-Congo hemorrhagic fever; MERS-CoV, Middle East respiratory syndrome coronavirus; RVF: Rift Valley fever; WNF, West Nile fever; HAV, hepatitis A virus; HEV, hepatitis E virus.

Table 1. Some Development Criteria and the Reported Outbreaks of the EIDs in human in EMR, 2001-2018[17,183-186]

Country	Population Million (2015)	HDI (2017)	Life Expectancy		GNI Per Capita (2011 PPP $) (2017)	Reported Outbreaks
			Female	Male		
Afghanistan	35.5	LHD	63.2	63.9	0	CCHF (2007-2012, 2016-2018), plague (2007), poliomyelitis (2001-2018), sandfly fever (2017)
Bahrain	1.5	VHHD	80.4	78.8	41 580	MERS-CoV (2016)
Djibouti	0.9	LHD	65.5	62.2	3105	AI (H5N1) (2006), Chikungunya (2011), dengue (2012)
Egypt	84.7	MHD	74.4	68.0	10 355	AI (H5N1) (2006-17), dengue (2015), MERS-CoV (2014), RVF (2003)
Iran	81.2	HHD	79.4	76.5	19 130	CCHF (2001-2018), diphtheria (2010-13), MERS-CoV (2014), tularemia (2017)
Iraq	38.3	MHD	78.8	74.8	17 789	AI (H5N1) (2006), CCHF (2018), diphtheria (2001, 2004, 2009)
Jordan	9.7	HHD	88.1	77.9	8288	MERS-CoV (2012)
Kuwait	4.1	VHHD	87.2	80.7	70 524	MERS-CoV (2013)
Lebanon	6.1	HHD	80.0	75.8	13 378	MERS-CoV (2014, 2017), sandfly fever (2007)
Libya	6.4	HHD	75.0	71.2	11 100	Plague (2009, 2011)
Morocco	35.7	MHD	74.8	73.3	7340	-
Oman	4.6	VHHD	79.5	75.5	36 290	CCHF (2011-2017), dengue (2014, 2018), MERS-CoV (2013-2018)
Pakistan	199.4	MHD	67.5	66.4	5311	AI (H5N1) (2007), CCHF (2001-2018), Chikungunya (2011, 2016-2018), dengue (2012-2018), diphtheria (2012-13, 2017-18), poliomyelitis (2001-2018)
Palestine	4.8	MHD	78.0	75.6	5055	-
Qatar	2.6	VHHD	81.7	79.6	116 818	MERS-CoV (2012-2017)
Saudi Arabia	32.9	VHHD	79.4	75.3	49 680	Diphtheria (2018), MERS-CoV (2012-18)
Somalia	13.8	LHD	57.3	53.7	7480	Chikungunya (2016), diphtheria (2012-13, 2018), poliomyelitis (2013-2014), RVF (2006-2007)
Sudan	40.5	LHD	72.1	68.9	4119	CCHF (2007-11), Chikungunya (2018), dengue (2012-2017), diphtheria (2001, 2008, 2011-2012, 2018), Meningococcal disease (2005-07), RVF (2007-2008)
Syria	18.3	LHD	75.0	65.5	2337	Poliomyelitis (2010, 2014, 2017)
Tunisia	11.5	HHD	80.8	76.2	10 275	MERS-CoV (2013)
UAE	9.4	VHHD	77.0	77.1	67 805	MERS-CoV (2013-2018)
Yemen	28.3	LHD	70.3	66.0	1239	Chikungunya (2010-2011), Dengue (2012, 2016-2018), Diphtheria (2017-2018), Meningococcal disease (2006-2007, 2016-2017), MERS-CoV (2014)

Abbreviations: GNI, gross national income; PPP, purchasing power parity; EMR, Eastern Mediterranean Region; EIDs, emerging infectious diseases; AI, Avian influenza; CCHF, Crimean-Congo hemorrhagic fever; HDI, Human Development Index (broken down into four tiers: VHHD, HHD, MHD, LHD); VHHD, very high human development (0.8-1.0); HHD, high human development (0.7-0.79); MHD, medium human development (0.55-.70); LHD, low human development (below 0.55); MERS-CoV, Middle East respiratory syndrome coronavirus; RVF: Rift Valley fever; UAE, United Arab Emirates.

fever, plague, and RVF, are transferred when an individual is in close contact or lives close to competent vectors and disease hosts. Coordination mechanisms between human and animal health sectors are weak in most countries in the region, so the risk of an increase in zoonotic disease transmission and emergence is present.

Surveillance systems in most countries of the region are not efficient to disseminate the data readily through the routine process. One probable reason can be poor recognition and reporting of some of the referenced diseases such as chikungunya, CCHF, MERS, plague, sandfly fever, tularemia, and WNF by physicians, as cases tend to occur as isolated incidences and sporadically in remote areas.

The WHO estimates that approximately 45% of infectious diseases occur in lower-income populations. For example, Yemen and Egypt have high percentage of poverty and are predisposed to several infectious diseases.[18,85,145] Furthermore, miscommunication or absence of communication in the health system and between countries can result in under-reporting that makes prediction of EIDs and RIDs difficult.

RIDs have recently displayed an upward incidence or prevalence worldwide. For instance, diphtheria outbreaks (in Iran, Pakistan and Sudan), human plague (in Afghanistan and Saudi Arabia), and dengue/dengue hemorrhagic fever (in Pakistan, Egypt, and Sudan) are classified as RIDs in EMR in recent years.[188,189]

One of the limitations of this paper is that countries differ in their methods of publishing research papers and reliable documents. The availability of data, studies, and papers may not be congruent between countries. Variation in the capacity of individual countries regarding surveillance and laboratory testing may present further limitations; however, the present review has attempted to provide relatively comprehensive information on the situation of the countries of the region by gathering existing data.

The Way Forward

Development and further strengthening of regional and national capacities for surveillance, laboratory diagnosis, prevention, and control of EIDs and RIDs, in line with requirements of the International Health Regulations (2005), is essential. While the WHO continues to provide guidance and support to all countries to improve preparedness, surveillance, and response to EIDs and RIDs in EMR,[183] considerable gaps and challenges remain to achieve these capacities.[190] A key strategic consideration for prevention and control of EIDs and RIDs is to establish surveillance capacity for early detection of any occurrences of EIDs or RIDs; as well as the prediction of unexpected occurrence of these high-threat pathogens; and to be able to effectively monitor occurrence patterns of these diseases both nationally and regionally. A wealth of available technology should be implemented in order to help predict, identify, and monitor EIDs or RIDs in the region.[191,192]

Other key strategic considerations should include effective coordination and collaboration within and between countries in the region, various scientific fields, and public health institutions to facilitate detection and response to EIDs or RIDs. Collaboration between multiple disciplines through the One Health approach for zoonotic diseases, for example, can lead to early detection, effective response, and better health for people, animals and the environment.[193] According to the 'One Health Paradigm' for global health, the emergence of the majority of new human infectious diseases originates from animal reservoirs. This underscores the need for coordinated surveillance to monitor zoonotic diseases among animals[194] and implementation of preventive One Health Interventions.[106]

Campaigns to control mosquito-borne diseases need to focus on clearly explaining why these diseases are a severe problem and how they can be controlled or avoided. Any strategy to further enhance individual and collective consciousness and behavior changes must also address the issues associated with poverty in order to achieve a greater impact.[195]

Further studies on EIDs and RIDs such as MERS, CCHF, AHF, and H5N1 are required to understand better the real epidemiological situation of these diseases in the region. This knowledge, alongside understanding other risk factors, can help reduce the risk of disease spread to humans.

It should also be noted that in most cases, due to absence of effective therapeutics or vaccines for most EIDs and RIDs, the governmental will to invest in prevention and control measures for these high-threat pathogens may be lacking in some countries in the region. Research is needed to address these critical knowledge gaps in diagnostic, therapeutic, and preventive measures for most EIDs and RIDs in the region.

Conclusion

The EMR countries are continuously experiencing large population movements associated with the Hajj and Arbaʽeen pilgrimage; internally displaced populations and refugees; and armed groups and transnational migrants. Furthermore, poverty, climate change, alongside the weak public health infrastructure, has predisposed this region to various EIDs and RIDs. Some diseases are endemic in this region and confer threats to international travellers. Several factors are important for the eradication of infectious diseases in this area, including political will, financial investment, cooperative international and local efforts, massive drug administration, vaccination, and surveillance for detection and diagnoses of lower recognized agents.

Understanding and documenting the regional scope and epidemiology of these infectious disease outbreaks will contribute greatly to prevent, rapidly identify, and promptly respond to these health threats in order to minimize deaths, limit geographic spread and interrupt transmission using evidence-based and high value interventions. Developing effective evidence-based public health control measures and intervention strategies to minimize the risk of infection is a key priority for countries in the region (Table 2). Research initiatives to learn more about the nature and impact of infectious diseases in the region are needed for better planning and control measures.

Better targeted investigations should be implemented to identify and prevent widespread emergence and re-emergence of infectious diseases. It is essential to defend the population

Table 2. The Major Drivers of Emerging and RIDs and Suggested Control Measures in the WHO EMR

Disease Name	Hepatitis virus A and E	Main Vector	Main Reservoir	Major Risk Factors of Emergence or Re-emergence	Suggested Control Measures	Reference
Acute hepatitis A and E	-	-	-	Consumption of sewage-contaminated water; use of indoor dry pits; war and conflict, famine and influx of refugees	Vaccination, providing adequate drinking water and sewage disposal	31,38
AHF	AHF virus	Ticks	Camel	Migratory birds, livestock trade, tick infestation; climate change	Tick control; control of livestock trade	49-51
AI (H5N1)	Avian influenza virus	-	Migratory bird, Poultry	Migratory birds; local bird trade, war and conflict	One Health strategy, active surveillance, testing and culling the areas where HPAI H5N1 was initially detected	57,59
Chikungunya	Chikungunya virus	*Aedes aegypti, Aedes albopictus*	-	Climate change, war and conflict, globalization, the significant increase in international travel and trade, vector resistance to pesticide, lack of competent surveillance system	Mosquito control; Environment hygiene; *Aedes* surveillance, collective consciousness	13,63,64
Cholera	*Vibrio cholera*	-	-	Poor living and sanitation; lack of clean water; war and conflict; global warming	Proper sanitation, hygienic life, environment hygiene, early warning system	140,142,144,146
CCHF	CCHF virus	Ticks	Livestock	Tick infestation, livestock contact and trading, nosocomial transmission; slaughtering during Eid al-Adha; climate change	Tick control; environment hygiene; education of high-risk population to reduce exposure to the virus	67,75,76
Dengue	Dengue virus	*Aedes aegypti, Aedes albopictus*	-	Climate change, war and conflict, globalization, the significant increase in international travel and trade, vector resistance to pesticide, lack of competent surveillance system	Mosquito control; environment hygiene; Aedes surveillance, collective consciousness	77,79,82,85
Diphtheria	*Corynebacterium diphtheria*	-	-	Low living condition and sanitation; war and conflict	Vaccination of at-risk population; quick disease diagnosis and management	146
Leishmaniasis	*Leishmania infantum, Leishmania tropica, Leishmania killicki*	Sandflies	Rodents and Dogs	War and conflict; poor environment hygiene; massive population displacement; climate change	One Health strategy; vector and reservoir control	21,176,179,181,196
Measles	Measles virus	-	-	War and conflict	Vaccination	87,92
Meningococcal disease	*Neisseria meningitidis*	-	-	Mass gathering in Hajj and Arba'een	Surveillance and vaccination	148-150,152
MERS	MERS-CoV	-	Dromedary camel	Camel contact, consumption of camel products, community contact, nosocomial infection, international travel	One Health strategy, hospital hygiene, farm biosecurity, animal quarantine	23,98,100,101,108

Table 2. Continued

Disease Name	Hepatitis virus A and E	Main Vector	Main Reservoir	Major Risk Factors of Emergence or Re-emergence	Suggested Control Measures	Reference
Plague	*Yersinia pestis*	Fleas	Rodents, livestock and carnivores	Weakness in the competent surveillance system and laboratory facilities to early diagnose	Monitoring and surveillance; rodent and flea surveillance in high-risk regions	154-157
Poliomyelitis	Poliovirus	-	-	War and conflict; weakness in the competent surveillance	Surveillance on all cases of acute flaccid paralysis, vaccination	136,137,139
Q fever	*Coxiella burnetii*	Ticks	Livestock	Mass gathering in Hajj and Arba'een	One Health strategy, monitoring and surveillance	159,160,163,197
Rabies	Rabies virus	-	Dogs, Foxes and other wild carnivores	War and conflict	One Health strategy, vaccination; reservoir control	113-117
RVF	RVF virus	Mosquitoes	Livestock	Mosquito and livestock contact, rainfall; climate change	Mosquito control; environment hygiene; control of livestock trade; animal vaccination, collective consciousness	119,121,122,124
Sandfly fever	Sandfly fever virus	Sandflies	-	Climate change; weakness in the competent surveillance system and laboratory facilities	Mosquito control, collective consciousness	125,126,131
Tularemia	*Francisella tularensis*	Ticks, mosquitoes	Rodents, hares	Weakness in the competent surveillance system and laboratory facilities; war and conflict	Monitoring and surveillance, collective consciousness	164,165,198
WNF	WNF virus	Culex mosquito	Birds, equines	Human dwelling at *Culex mosquito* breeding sites; weakness in the competent surveillance system and laboratory facilities	Mosquito control; environment hygiene, collective consciousness	134,135

Abbreviations: EMR, Eastern Mediterranean Region; RIDs, re-emerging infectious diseases; WHO, World Health Organization; AHF, Alkhurma hemorrhagic fever; CCHF, Crimean-Congo hemorrhagic fever; MERS-CoV, Middle East respiratory syndrome coronavirus; RVF, Rift Valley fever; WNF, West Nile fever; HPAI, highly pathogenic avian influenza.

through multifactorial efforts, including coordinated, well-prepared and well-equipped public health systems alongside partnerships among clinicians, laboratories and public health agencies. Besides, the application of advanced and proper diagnostic methods and surveillance contributes to achieving better results in limited time.

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Authors declare that they have no competing interests.

Authors' contributions
EM carried out the design of the study. AG and SANM participated in gathering the data, and prepared the first draft of manuscript. All authors critically reviewed the manuscript, applied comments and finalized the manuscript.

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Authors' affiliations
[1]Department of Epidemiology and Biostatistics, Research Centre for Emerging and Re-emerging Infectious Diseases, Pasteur Institute of Iran, Tehran, Iran. [2]Infectious Hazards Management, World Health Organization, Eastern Mediterranean Regional Office, Cairo, Egypt. [3]Department of Primary Care and Public Health, School of Public Health, Faculty of Medicine, Imperial College, London, UK. [4]Department of Arboviruses and Viral Hemorrhagic Fevers, Research Centre for Emerging and Re-emerging Infectious Diseases, Pasteur Institute of Iran, Tehran, Iran. [5]Centre for Communicable Disease Control, Ministry of Health and Medical Education, Tehran, Iran. [6]Office of Health Affairs, Ministry of Health, Muscat, Oman. [7]Department of Animal Resources, Ministry of Municipality and Environment, Doha, Qatar. [8]School of Laboratory Medicine and Medical Sciences, College of Health Sciences, University of KwaZulu Natal, Durban, South Africa. [9]Ministry of Public Health, Doha, Qatar. [10]Laboratory of Community Medicine, Preventive Medicine and Hygiene, Public Health Department, Faculty of Medicine and Pharmacy, Mohammed V University, Rabat, Morocco. [11]Laboratory of Epidemiology, Biostatistics and Clinical Research, Public Health Department, Faculty of Medicine and Pharmacy, Mohammed V University, Rabat, Morocco. [12]Department of Experimental Pathology, Immunology and Microbiology Center for Infectious Diseases Research, American University of Beirut & Medical Center, Beirut, Lebanon. [13]University of Nebraska Medical Center, Omaha, NE, USA. [14]Global Health Strategists & Implementers (GHSI), Islamabad, Pakistan. [15]Infectious Hazard Management Department, World Health Organization, Kabul, Afghanistan. [16]Communicable Diseases Control Department, Public Health Directorate Unit, Ministry of Health, Kuwait City, Kuwait. [17]Centre for Public Health, Queen's University Belfast, Belfast, UK.

References
1. Woolhouse ME. Population biology of emerging and re-emerging pathogens. *Trends Microbiol*. 2002;10(10 Suppl):S3-7. doi:10.1016/s0966-842x(02)02428-9
2. Petersen E, Petrosillo N, Koopmans M. Emerging infections-an increasingly important topic: review by the Emerging Infections Task Force. *Clin Microbiol Infect*. 2018;24(4):369-375. doi:10.1016/j.cmi.2017.10.035
3. World Health Organization (WHO). *The Work of WHO in the Eastern Mediterranean Region: Annual Report of the Regional Director 2014*. World Health Organization. Regional Office for the Eastern Mediterranean; 2015.
4. Morens DM, Folkers GK, Fauci AS. The challenge of emerging and re-emerging infectious diseases. *Nature*. 2004;430(6996):242-249. doi:10.1038/nature02759
5. The World Bank. *Population, Total*. The World Bank; 2018. https://data.worldbank.org/indicator/SP.POP.TOTL. Accessed February 24, 2018.
6. Dabrowski M, De Wulf L. *Economic Development, Trade and Investment in the Eastern and Southern Mediterranean Region*. SSRN Electronic Journal; 2013. doi:10.2139/ssrn.2202884
7. The World Bank. *GDP Growth (Annual %)*. The World Bank; 2016. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG. Accessed February 24, 2018.
8. McMichael AJ. Global climate change and health: an old story writ large. In: *Climate Change and Human Health: Risks and Responses*. Geneva, Switzerland: WHO; 2003.
9. Mangold KA, Reynolds SL. A review of dengue fever: a resurging tropical disease. *Pediatr Emerg Care*. 2013;29(5):665-669. doi:10.1097/PEC.0b013e31828ed30e
10. Ahmed QA, Arabi YM, Memish ZA. Health risks at the Hajj. *Lancet*. 2006; 367(9515):1008-1015. doi:10.1016/s0140-6736(06)68429-8
11. Koçarslan S, Turan E, Ekinci T, Yesilova Y, Apari R. Clinical and histopathological characteristics of cutaneous leishmaniasis in Sanliurfa city of Turkey including Syrian refugees. *Indian J Pathol Microbiol*. 2013; 56(3):211-215. doi:10.4103/0377-4929.120367
12. Niazi AU, Jawad MJ, Amirnajad A, Durr PA, Williams DT. Crimean-Congo hemorrhagic fever, Herat province, Afghanistan, 2017. *Emerg Infect Dis*. 2019;25(8):1596-1598. doi:10.3201/eid2508.181491
13. Rauf M, Fatima Tuz Z, Manzoor S, Mehmood A, Bhatti S. Outbreak of chikungunya in Pakistan. *Lancet Infect Dis*. 2017;17(3):258. doi:10.1016/s1473-3099(17)30074-9
14. ProMED-mail. Chikungunya - Sudan (05): (Kassala) cases, health workers, MOH. ProMED-mail 2018; 16 Oct: 20181020.6095579. http://www.promedmail.org. Accessed October 20, 2018.
15. Khalil I, Colombara DV, Forouzanfar MH, et al. Burden of diarrhea in the Eastern Mediterranean Region, 1990-2013: findings from the Global Burden of Disease Study 2013. *Am J Trop Med Hyg*. 2016;95(6):1319-1329. doi:10.4269/ajtmh.16-0339
16. Berger S. *Infectious Diseases of Pakistan: 2017 Edition*. GIDEON Informatics Inc; 2017.
17. World Health Organization (WHO). Diphtheria Reported Cases. Geneva: WHO; 2019. https://apps.who.int/immunization_monitoring/globalsummary/timeseries/tsincidencediphtheria.html.
18. Kayali G, Kandeil A, El-Shesheny R, et al. Avian influenza A(H5N1) virus in Egypt. *Emerg Infect Dis*. 2016;22(3):379-388. doi:10.3201/eid2203.150593
19. Mockenhaupt FP, Barbre KA, Jensenius M, et al. Profile of illness in Syrian refugees: a GeoSentinel analysis, 2013 to 2015. *Euro Surveill*. 2016;21(10):30160. doi:10.2807/1560-7917.es.2016.21.10.30160
20. Khan NH, Bari AU, Hashim R, et al. Cutaneous leishmaniasis in Khyber Pakhtunkhwa province of Pakistan: clinical diversity and species-level diagnosis. *Am J Trop Med Hyg*. 2016;95(5):1106-1114. doi:10.4269/ajtmh.16-0343
21. Reithinger R, Aadil K, Kolaczinski J, Mohsen M, Hami S. Social impact of leishmaniasis, Afghanistan. *Emerg Infect Dis*. 2005;11(4):634-636. doi:10.3201/eid1104.040945
22. Wagner AL, Mubarak MY, Johnson LE, Porth JM, Yousif JE, Boulton ML. Trends of vaccine-preventable diseases in Afghanistan from the Disease Early Warning System, 2009-2015. *PLoS One*. 2017;12(6):e0178677. doi:10.1371/journal.pone.0178677
23. Alqahtani AS, Rashid H, Basyouni MH, Alhawassi TM, BinDhim NF. Public response to MERS-CoV in the Middle East: iPhone survey in six countries. *J Infect Public Health*. 2017;10(5):534-540. doi:10.1016/j.jiph.2016.11.015
24. Carias C, O'Hagan JJ, Jewett A, et al. Exportations of symptomatic cases of MERS-CoV infection to countries outside the Middle East. *Emerg Infect Dis*. 2016;22(4):723-725. doi:10.3201/eid2204.150976
25. Nowotny N, Kolodziejek J. Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels, Oman, 2013. *Euro Surveill*. 2014; 19(16):20781. doi:10.2807/1560-7917.es2014.19.16.20781
26. Leslie T, Whitehouse CA, Yingst S, et al. Outbreak of gastroenteritis caused by *Yersinia pestis* in Afghanistan. *Epidemiol Infect*. 2011;139(5):728-735. doi:10.1017/s0950268810001792
27. Norris A, Hachey K, Curtis A, Bourdeaux M. Crippling violence: conflict and incident polio in Afghanistan. *PLoS One*. 2016;11(3):e0149074. doi:10.1371/journal.pone.0149074
28. WHO Eastern Mediterranean Region. *Polio Eradication Initiative*. WHO; 2019. http://www.emro.who.int/polio/countries. Accessed January 16, 2019.

29. Faix DJ, Harrison DJ, Riddle MS, et al. Outbreak of Q fever among US military in western Iraq, June-July 2005. *Clin Infect Dis*. 2008;46(7):e65-68. doi:10.1086/528866
30. Saeed KMI, Ansari J, Asghar RJ, Ahadi J. Concurrent brucellosis and Q fever infection: a case control study in Bamyan province, Afghanistan in 2011. *Int J Infect Dis*. 2012;16:e37. doi:10.1016/j.ijid.2012.05.094
31. Asghar RJ. Hepatitis A and E: not to be forgotten. *East Mediterr Health J*. 2014;20(3):212-213.
32. Rezig D, Ouneissa R, Mhiri L, et al. [Seroprevalences of hepatitis A and E infections in Tunisia]. *Pathol Biol (Paris)*. 2008;56(3):148-153. doi:10.1016/j.patbio.2007.09.026
33. Bawazir AA, Hart CA, Sallam TA, Parry CM, Beeching NJ, Cuevas LE. Seroepidemiology of hepatitis A and hepatitis E viruses in Aden, Yemen. *Trans R Soc Trop Med Hyg*. 2010;104(12):801-805. doi:10.1016/j.trstmh.2010.08.007
34. Turky AM, Akram W, Al-Naaimi AS, Omer AR, Al-Rawi JR. Analysis of acute viral hepatitis (A and E) in Iraq. *Glob J Health Sci*. 2011;3(1):70-76. doi:10.5539/gjhs.v3n1p70
35. Darwish MA, Faris R, Clemens JD, Rao MR, Edelman R. High seroprevalence of hepatitis A, B, C, and E viruses in residents in an Egyptian village in The Nile Delta: a pilot study. *Am J Trop Med Hyg*. 1996; 54(6):554-558. doi:10.4269/ajtmh.1996.54.554
36. Gebreel AO, Christie AB. Viral hepatitis in children: a study in Libya. *Ann Trop Paediatr*. 1983;3(1):9-11. doi:10.1080/02724936.1983.11748260
37. Bouskraoui M, Bourrous M, Amine M. [Prevalence of anti-hepatitis A virus antibodies in children in Marrakech]. *Arch Pediatr*. 2009;16 Suppl 2:S132-136. doi:10.1016/s0929-693x(09)75317-5
38. Ghasemian A. Prevalence of hepatitis A across various countries in the Middle East, African and Eastern European countries. *Caspian J Intern Med*. 2016;7(4):302-303.
39. Pröll S, Nothdurft HD. [The risk of contracting hepatitis A or hepatitis B run by visitors to the Mediterranean and Eastern Europe]. *MMW Fortschr Med*. 2004;146(20):51-54.
40. Bizri AR, Fares J, Musharrafieh U. Infectious diseases in the era of refugees: hepatitis A outbreak in Lebanon. *Avicenna J Med*. 2018;8(4):147-152. doi:10.4103/ajm.AJM_130_18
41. Miri SM, Alavian SM. Epidemiology of hepatitis a virus infections in Syria, 2017; war and asylum seekers: a global threat. *Iran Red Crescent Med J*. 2017;19(11):e63622. doi:10.5812/ircmj.63622
42. Esmaeilzadeh A, Ganji A, Bahari A, Goshayeshi L. Prevalence of hepatitis E in Iran: a systematic review of the literature. *Rev Clin Med*. 2017; 4(4):152-159. doi:10.22038/rcm.2017.20169.1187
43. Kumar RM, Uduman S, Rana S, Kochiyil JK, Usmani A, Thomas L. Sero-prevalence and mother-to-infant transmission of hepatitis E virus among pregnant women in the United Arab Emirates. *Eur J Obstet Gynecol Reprod Biol*. 2001;100(1):9-15. doi:10.1016/s0301-2115(01)00448-1
44. Saad MD, Hussein HA, Bashandy MM, et al. Hepatitis E virus infection in work horses in Egypt. *Infect Genet Evol*. 2007;7(3):368-373. doi:10.1016/j.meegid.2006.07.007
45. Bryan JP, Iqbal M, Tsarev S, et al. Epidemic of hepatitis E in a military unit in Abbotrabad, Pakistan. *Am J Trop Med Hyg*. 2002;67(6):662-668. doi:10.4269/ajtmh.2002.67.662
46. Ayoola EA, Want MA, Gadour MO, Al-Hazmi MH, Hamza MK. Hepatitis E virus infection in haemodialysis patients: a case-control study in Saudi Arabia. *J Med Virol*. 2002;66(3):329-334. doi:10.1002/jmv.2149
47. Madani TA. Alkhumra virus infection, a new viral hemorrhagic fever in Saudi Arabia. *J Infect*. 2005;51(2):91-97. doi:10.1016/j.jinf.2004.11.012
48. Madani TA, Azhar EI, Abuelzein el TM, et al. Alkhumra (Alkhurma) virus outbreak in Najran, Saudi Arabia: epidemiological, clinical, and laboratory characteristics. *J Infect*. 2011;62(1):67-76. doi:10.1016/j.jinf.2010.09.032
49. Al-Tawfiq JA, Memish ZA. Alkhurma hemorrhagic fever virus. *Microbes Infect*. 2017;19(6):305-310. doi:10.1016/j.micinf.2017.04.004
50. Memish ZA, Fagbo SF, Osman Ali A, AlHakeem R, Elnagi FM, Bamgboye EA. Is the epidemiology of alkhurma hemorrhagic fever changing?: a three-year overview in Saudi Arabia. *PLoS One*. 2014;9(2):e85564. doi:10.1371/journal.pone.0085564
51. Carletti F, Castilletti C, Di Caro A, et al. Alkhurma hemorrhagic fever in travelers returning from Egypt, 2010. *Emerg Infect Dis*. 2010;16(12):1979-1982. doi:10.3201/eid1612.101092
52. Musso M, Galati V, Stella MC, Capone A. A case of Alkhumra virus infection. *J Clin Virol*. 2015;66:12-14. doi:10.1016/j.jcv.2015.02.019
53. Horton KC, Fahmy NT, Watany N, et al. Crimean Congo hemorrhagic fever virus and Alkhurma (Alkhumra) virus in ticks in Djibouti. *Vector Borne Zoonotic Dis*. 2016;16(10):680-682. doi:10.1089/vbz.2016.1951
54. Bahgat MM, Kutkat MA, Nasraa MH, et al. Characterization of an avian influenza virus H5N1 Egyptian isolate. *J Virol Methods*. 2009;159(2):244-250. doi:10.1016/j.jviromet.2009.04.008
55. Young SG, Kitchen A, Kayali G, Carrel M. Unlocking pandemic potential: prevalence and spatial patterns of key substitutions in avian influenza H5N1 in Egyptian isolates. *BMC Infect Dis*. 2018;18(1):314. doi:10.1186/s12879-018-3222-6
56. Kammon A, Heidari A, Dayhum A, et al. Characterization of avian influenza and Newcastle disease viruses from poultry in Libya. *Avian Dis*. 2015;59(3):422-430. doi:10.1637/11068-032215-ResNote.1
57. Abubakar A, Elkholy A, Barakat A, et al. Pandemic influenza preparedness (PIP) framework: Progress challenges in improving influenza preparedness response capacities in the Eastern Mediterranean Region, 2014-2017. *J Infect Public Health*. 2020;13(3):446-450. doi:10.1016/j.jiph.2019.03.006
58. World Health Organization (WHO). Cumulative Number of Confirmed Human Cases of Avian Influenza A(H5N1) Reported to WHO (2003-2016). WHO; 2016. http://www.who.int/influenza/human_animal_interface/H5N1_cumulative_table_archives/en/. Accessed November 1, 2016.
59. World Health Organization (WHO). Avian Influenza A(H5N1) Situation Update, Egypt, September 2016. WHO; 2016. http://www.emro.who.int/surveillance-forecasting-response/surveillance-news/avian-influenza-ah5n1-situation-update-egypt-september-2016.html. Accessed November 1, 2016.
60. Alkhamis M, Hijmans RJ, Al-Enezi A, Martínez-López B, Perea AM. The use of spatial and spatiotemporal modeling for surveillance of H5N1 highly pathogenic avian influenza in poultry in the Middle East. *Avian Dis*. 2016;60(1 Suppl):146-155. doi:10.1637/11106-042115-Reg
61. Khan W, El Rifay AS, Malik M, Kayali G. Influenza research in the Eastern Mediterranean Region: a review. *Oman Med J*. 2017;32(5):359-364. doi:10.5001/omj.2017.70
62. Al-Abri SS, Abdel-Hady DM, Al Mahrooqi SS, Al-Kindi HS, Al-Jardani AK, Al-Abaidani IS. Epidemiology of travel-associated infections in Oman 1999-2013: a retrospective analysis. *Travel Med Infect Dis*. 2015; 13(5):388-393. doi:10.1016/j.tmaid.2015.08.006
63. Humphrey JM, Cleton NB, Reusken C, Glesby MJ, Koopmans MPG, Abu-Raddad LJ. Urban chikungunya in the Middle East and North Africa: a systematic review. *PLoS Negl Trop Dis*. 2017;11(6):e0005707. doi:10.1371/journal.pntd.0005707
64. Malik MR, Mnzava A, Mohareb E, et al. Chikungunya outbreak in Al-Hudaydah, Yemen, 2011: epidemiological characterization and key lessons learned for early detection and control. *J Epidemiol Glob Health*. 2014; 4(3):203-211. doi:10.1016/j.jegh.2014.01.004
65. Mansoor H. Alarming Rise in Chikungunya Virus Cases in Sindh. DAWN website. https://www.dawn.com/news/1357922. Published September 16, 2017.
66. World Health Organization (WHO). Weekly Epidemiological Monitor. WHO; 2017.
67. Al-Abri SS, Abaidani IA, Fazlalipour M, et al. Current status of Crimean-Congo haemorrhagic fever in the World Health Organization Eastern Mediterranean Region: issues, challenges, and future directions. *Int J Infect Dis*. 2017;58:82-89. doi:10.1016/j.ijid.2017.02.018
68. Wasfi F, Dowall S, Ghabbari T, et al. Sero-epidemiological survey of Crimean-Congo hemorrhagic fever virus in Tunisia. *Parasite*. 2016;23:10. doi:10.1051/parasite/2016010
69. Aziz TA, Ali DJ, Jaff DO. Molecular and serological detection of Crimean-Congo hemorrhagic fever virus in Sulaimani province, Iraq. *J Biosci Med*. 2016;4(4):36-42. doi:10.4236/jbm.2016.44006
70. Al-Abri SS, Hewson R, Al-Kindi H, et al. Molecular epidemiology and high mortality of Crimean-Congo hemorrhagic fever in Oman: a re-emerging infection. *bioRxiv*. 2018:502641. doi:10.1101/502641
71. Sahak MN, Arifi F, Saeedzai SA. Descriptive epidemiology of Crimean-Congo Hemorrhagic Fever (CCHF) in Afghanistan: reported cases to National Surveillance System, 2016-2018. *Int J Infect Dis*. 2019;88:135-140. doi:10.1016/j.ijid.2019.08.016
72. Mostafavi E, Haghdoost A, Khakifirouz S, Chinikar S. Spatial analysis of Crimean Congo hemorrhagic fever in Iran. *Am J Trop Med Hyg*. 2013; 89(6):1135-1141. doi:10.4269/ajtmh.12-0509

73. Karim AM, Hussain I, Lee JH, Park KS, Lee SH. Surveillance of Crimean-Congo haemorrhagic fever in Pakistan. *Lancet Infect Dis*. 2017;17(4):367-368. doi:10.1016/s1473-3099(17)30119-6
74. Palomar AM, Portillo A, Santibáñez P, et al. Crimean-Congo hemorrhagic fever virus in ticks from migratory birds, Morocco. *Emerg Infect Dis*. 2013;19(2):260-263. doi:10.3201/eid1902.121193
75. Široký P, Bělohlávek T, Papoušek I, et al. Hidden threat of tortoise ticks: high prevalence of Crimean-Congo haemorrhagic fever virus in ticks *Hyalomma aegyptium* in the Middle East. *Parasit Vectors*. 2014;7:101. doi:10.1186/1756-3305-7-101
76. Al-Abri SS, Hewson R, Al-Kindi H, et al. Clinical and molecular epidemiology of Crimean-Congo hemorrhagic fever in Oman. *PLoS Negl Trop Dis*. 2019;13(4):e0007100. doi:10.1371/journal.pntd.0007100
77. Humphrey JM, Cleton NB, Reusken CB, Glesby MJ, Koopmans MP, Abu-Raddad LJ. Dengue in the Middle East and North Africa: a systematic review. *PLoS Negl Trop Dis*. 2016;10(12):e0005194. doi:10.1371/journal.pntd.0005194
78. Shahhosseini N, Chinikar S, Nowotny N, Fooks AR, Schmidt-Chanasit J. Genetic analysis of imported dengue virus strains by Iranian travelers. *Asian Pac J Trop Dis*. 2016;6(11):850-853. doi:10.1016/S2222-1808(16)61144-1
79. Al Awaidy ST, Khamis F. Dengue fever: an emerging disease in Oman requiring urgent public health interventions. *Oman Med J*. 2019;34(2):91-93. doi:10.5001/omj.2019.18
80. Humphrey JM, Al-Absi ES, Hamdan MM, et al. Dengue and chikungunya seroprevalence among Qatari nationals and immigrants residing in Qatar. *PLoS One*. 2019;14(1):e0211574. doi:10.1371/journal.pone.0211574
81. Doosti S, Yaghoobi-Ershadi MR, Schaffner F, et al. Mosquito surveillance and the first record of the invasive mosquito species *Aedes* (*Stegomyia*) *albopictus* (Skuse) (Diptera: Culicidae) in southern Iran. *Iran J Public Health*. 2016;45(8):1064-1073.
82. Ducheyne E, Tran Minh NN, Haddad N, et al. Current and future distribution of *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) in WHO Eastern Mediterranean Region. *Int J Health Geogr*. 2018;17(1):4. doi:10.1186/s12942-018-0125-0
83. Bouattour A, Khrouf F, Rhim A, M'Ghirbi Y. First detection of the Asian tiger mosquito, *Aedes (Stegomyia) albopictus* (Diptera: Culicidae), in Tunisia. *J Med Entomol*. 2019;56(4):1112-1115. doi:10.1093/jme/tjz026
84. Kanani K, Amr Z, Katbeh-Bader A, Arbaji M. First record of *Aedes albopictus* in Jordan. *J Am Mosq Control Assoc*. 2017;33(2):134-135. doi:10.2987/17-6641.1
85. Alghazali KA, Teoh BT, Loong SK, et al. Dengue outbreak during ongoing civil war, Taiz, Yemen. *Emerg Infect Dis*. 2019;25(7):1397-1400. doi:10.3201/eid2507.180046
86. World Health Organization (WHO). Measles, Fact Sheet. WHO; 2018. http://www.who.int/en/news-room/fact-sheets/detail/measles. Accessed July 10, 2018.
87. Teleb N, Lebo E, Ahmed H, et al. Progress toward measles elimination--Eastern Mediterranean Region, 2008-2012. *MMWR Morb Mortal Wkly Rep*. 2014;63(23):511-515.
88. World Health Organization (WHO). Measles situation in Eastern Mediterranean Region; in: WHO Regional Office for Eastern Mediterranean Report. Vol 12. Cairo, Egypt: WHO; 2019.
89. Alwan A. The Cost of War. WHO; 2015. http://www.who.int/mediacentre/commentaries/war-cost/en/. Accessed November 26, 2018.
90. ProMED-mail. Measles - Yemen (05): (Amran, Dhamar) fatal, increasing incidence. ProMED-mail 2018; 22 Dec: 20181223.6220714. http://www.promedmail.org. Accessed December 23, 2018.
91. Raad, II, Chaftari AM, Dib RW, Graviss EA, Hachem R. Emerging outbreaks associated with conflict and failing healthcare systems in the Middle East. *Infect Control Hosp Epidemiol*. 2018;39(10):1230-1236. doi:10.1017/ice.2018.177
92. Mere MO, Goodson JL, Chandio AK, et al. Progress toward measles elimination-Pakistan, 2000-2018. *MMWR Morb Mortal Wkly Rep*. 2019; 68(22):505-510. doi:10.15585/mmwr.mm6822a4
93. World Health Organization (WHO). *Summary Report on the Meeting of the Eastern Mediterranean Regional Technical Advisory Group [RTAG] on Immunization, Muscat, Oman 14 December 2017*. World Health Organization, Regional Office for the Eastern Mediterranean; 2018.
94. Zaki AM, van Boheemen S, Bestebroer TM, Osterhaus AD, Fouchier RA. Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. *N Engl J Med*. 2012;367(19):1814-1820. doi:10.1056/NEJMoa1211721
95. Hemida MG, Al-Naeem A, Perera RA, Chin AW, Poon LL, Peiris M. Lack of Middle East respiratory syndrome coronavirus transmission from infected camels. *Emerg Infect Dis*. 2015;21(4):699-701. doi:10.3201/eid2104.141949
96. Zumla A, Hui DS, Perlman S. Middle East respiratory syndrome. *Lancet*. 2015;386(9997):995-1007. doi:10.1016/s0140-6736(15)60454-8
97. World Health Organization (WHO). *Investigation of Cases of Human Infection with Middle East Respiratory Syndrome Coronavirus (MERS-Cov): Interim Guidance*. WHO; 2018.
98. Al-Abaidani IS, Al-Maani AS, Al-Kindi HS, et al. Overview of preparedness and response for Middle East respiratory syndrome coronavirus (MERS-CoV) in Oman. *Int J Infect Dis*. 2014;29:309-310. doi:10.1016/j.ijid.2014.10.003
99. WHO Eastern Mediterranean Regional office. *MERS Situation Update*. Vol 10. Cairo, Egypt: WHO; 2017.
100. Poletto C, Boëlle PY, Colizza V. Risk of MERS importation and onward transmission: a systematic review and analysis of cases reported to WHO. *BMC Infect Dis*. 2016;16(1):448. doi:10.1186/s12879-016-1787-5
101. Farag E, Sikkema RS, Vinks T, et al. Drivers of MERS-CoV emergence in Qatar. *Viruses*. 2018;11(1):22. doi:10.3390/v11010022
102. Moniri A, Marjani M, Tabarsi P, Yadegarynia D, Nadji SA. Health care associated Middle East respiratory syndrome (MERS): a case from Iran. *Tanaffos*. 2015;14(4):262-267.
103. Memish ZA, Zumla AI, Al-Hakeem RF, Al-Rabeeah AA, Stephens GM. Family cluster of Middle East respiratory syndrome coronavirus infections. *N Engl J Med*. 2013;368(26):2487-2494. doi:10.1056/NEJMoa1303729
104. Hunter JC, Nguyen D, Aden B, et al. Transmission of Middle East respiratory syndrome coronavirus infections in healthcare settings, Abu Dhabi. *Emerg Infect Dis*. 2016;22(4):647-656. doi:10.3201/eid2204.151615
105. World Health Organisation. MERS cluster in Wadi Aldwaser, Saudi Arabia Weekly Epidemiological Report. 2019;12(7).
106. Farag E, Nour M, Islam MM, et al. Qatar experience on One Health approach for Middle-East respiratory syndrome coronavirus, 2012-2017: A viewpoint. *One Health*. 2019;7:100090. doi:10.1016/j.onehlt.2019.100090
107. Chu DK, Poon LL, Gomaa MM, et al. MERS coronaviruses in dromedary camels, Egypt. *Emerg Infect Dis*. 2014;20(6):1049-1053. doi:10.3201/eid2006.140299
108. Ali M, El-Shesheny R, Kandeil A, et al. Cross-sectional surveillance of Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels and other mammals in Egypt, August 2015 to January 2016. *Euro Surveill*. 2017;22(11):30487. doi:10.2807/1560-7917.es.2017.22.11.30487
109. Mohran KA, Farag EA, Reusken CB, et al. The sample of choice for detecting Middle East respiratory syndrome coronavirus in asymptomatic dromedary camels using real-time reversetranscription polymerase chain reaction. *Rev Sci Tech*. 2016;35(3):905-911. doi:10.20506/rst.35.3.2578
110. Farag EA, Reusken CB, Haagmans BL, et al. High proportion of MERS-CoV shedding dromedaries at slaughterhouse with a potential epidemiological link to human cases, Qatar 2014. *Infect Ecol Epidemiol*. 2015;5:28305. doi:10.3402/iee.v5.28305
111. Yusof MF, Eltahir YM, Serhan WS, et al. Prevalence of Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels in Abu Dhabi Emirate, United Arab Emirates. *Virus Genes*. 2015;50(3):509-513. doi:10.1007/s11262-015-1174-0
112. Conzade R, Grant R, Malik MR, et al. Reported direct and indirect contact with dromedary camels among laboratory-confirmed MERS-CoV cases. *Viruses*. 2018;10(8). doi:10.3390/v10080425
113. Horton DL, McElhinney LM, Freuling CM, et al. Complex epidemiology of a zoonotic disease in a culturally diverse region: phylogeography of rabies virus in the Middle East. *PLoS Negl Trop Dis*. 2015;9(3):e0003569. doi:10.1371/journal.pntd.0003569
114. Abaidani IA, Abri SA, Prakash KP, Hussain MH, Hussain MH, Rawahi AH. Epidemiology of rabies in Oman: a retrospective study (1991-2013). *East Mediterr Health J*. 2015;21(8):591-597.
115. Bannazadeh Baghi H, Alinezhad F, Kuzmin I, Rupprecht CE. A perspective on rabies in the Middle East-beyond neglect. *Vet Sci*. 2018;5(3). doi:10.3390/vetsci5030067
116. Gautret P, Ribadeau-Dumas F, Parola P, Brouqui P, Bourhy H. Risk for rabies importation from North Africa. *Emerg Infect Dis*. 2011;17(12):2187-2193. doi:10.3201/eid1712.110300

117. Kassir MF, El Zarif T, Kassir G, Berry A, Musharrafieh U, Bizri AR. Human rabies control in Lebanon: a call for action. *Epidemiol Infect*. 2018;147:1-8. doi:10.1017/s095026881800300x
118. Outbreak of Rift Valley fever--Saudi Arabia, August-October, 2000. *MMWR Morb Mortal Wkly Rep*. 2000;49(40):905-908.
119. Madani TA, Al-Mazrou YY, Al-Jeffri MH, et al. Rift Valley fever epidemic in Saudi Arabia: epidemiological, clinical, and laboratory characteristics. *Clin Infect Dis*. 2003;37(8):1084-1092. doi:10.1086/378747
120. Awaidy SA, Al Hashami H. Zoonotic diseases in Oman: successes, challenges, and future directions. *Vector Borne Zoonotic Dis*. 2020;20(1):1-9. doi:10.1089/vbz.2019.2458
121. Hassan OA, Ahlm C, Evander M. A need for One Health approach-lessons learned from outbreaks of Rift Valley fever in Saudi Arabia and Sudan. *Infect Ecol Epidemiol*. 2014;4. doi:10.3402/iee.v4.20710
122. Hassan OA, Ahlm C, Sang R, Evander M. The 2007 Rift Valley fever outbreak in Sudan. *PLoS Negl Trop Dis*. 2011;5(9):e1229. doi:10.1371/journal.pntd.0001229
123. Fakour S, Naserabadi S, Ahmadi E. The first positive serological study on Rift Valley fever in ruminants of Iran. *J Vector Borne Dis*. 2017;54(4):348-352. doi:10.4103/0972-9062.225840
124. Arsevska E, Hellal J, Mejri S, et al. Identifying areas suitable for the occurrence of Rift Valley fever in North Africa: implications for surveillance. *Transbound Emerg Dis*. 2016;63(6):658-674. doi:10.1111/tbed.12331
125. Downs JW, Flood DT, Orr NH, Constantineau JA, Caviness JW. Sandfly fever in Afghanistan-a sometimes overlooked disease of military importance: a case series and review of the literature. *US Army Med Dep J*. 2017(3-17):60-66.
126. Feinsod FM, Ksiazek TG, Scott RM, et al. Sand fly fever-Naples infection in Egypt. *Am J Trop Med Hyg*. 1987;37(1):193-196. doi:10.4269/ajtmh.1987.37.193
127. Tesh RB, Saidi S, Gajdamovic SJ, Rodhain F, Vesenjak-Hirjan J. Serological studies on the epidemiology of sandfly fever in the Old World. *Bull World Health Organ*. 1976;54(6):663-674.
128. Cohen R, Babushkin F, Shimoni Z, Shapiro M, Lustig Y. Sandfly virus encephalitis in Israel: two case reports and a review. *J Neuroinfect Dis*. 2017;8(1):240. doi:10.4172/2314-7326.1000240
129. Badakhshan M, Yaghoobi-Ershadi MR, Moin-Vaziri V, et al. Spatial distribution of phlebotomine sand flies (Diptera: Psychodidae) as phlebovirus vectors in different areas of Iran. *J Med Entomol*. 2018; 55(4):846-854. doi:10.1093/jme/tjy033
130. Depaquit J, Pesson B, Augot D, Hamilton JG, Lawyer P, Léger N. Proceedings of the IX International Symposium on Phlebotomine Sandflies (ISOPS IX), Reims, France, June 28th-July 1st, 2016. *Parasite*. 2016;23:E1. doi:10.1051/parasite/2016051
131. Shiraly R, Khosravi A, Farahangiz S. Seroprevalence of sandfly fever virus infection in military personnel on the western border of Iran. *J Infect Public Health*. 2017;10(1):59-63. doi:10.1016/j.jiph.2016.02.014
132. Andayi F, Charrel RN, Kieffer A, et al. A sero-epidemiological study of arboviral fevers in Djibouti, Horn of Africa. *PLoS Negl Trop Dis*. 2014; 8(12):e3299. doi:10.1371/journal.pntd.0003299
133. Failloux AB, Bouattour A, Faraj C, et al. Surveillance of arthropod-borne viruses and their vectors in the Mediterranean and Black Sea regions within the MediLabSecure Network. *Curr Trop Med Rep*. 2017;4(1):27-39. doi:10.1007/s40475-017-0101-y
134. Eybpoosh S, Fazlalipour M, Baniasadi V, et al. Epidemiology of West Nile Virus in the Eastern Mediterranean Region: a systematic review. *PLoS Negl Trop Dis*. 2019;13(1):e0007081. doi:10.1371/journal.pntd.0007081
135. World Health Organization. West Nile fever in Tunisia: update. In: World Health Organization ROfEM, ed. Weekly Epidemiological Monitor. Vol 11. Cairo, Egypt: World Health Organization, Regional Office for Eastern Mediterranean; 2018.
136. Jenabi E, Shirani F, Khazaei S. Alarm of circulating wild poliovirus and of vaccine-derived poliovirus in Middle East countries as a potential risk for re-emerging of polio in Iran. *Int J Pediatr*. 2019;7(3):9071-9073. doi:10.22038/ijp.2018.35530.3107
137. Mbaeyi C, Wadood ZM, Moran T, et al. Strategic response to an outbreak of circulating vaccine-derived poliovirus type 2-Syria, 2017-2018. *MMWR Morb Mortal Wkly Rep*. 2018;67(24):690-694. doi:10.15585/mmwr.mm6724a5
138. Kamadjeu R, Gathenji C. Designing and implementing an electronic dashboard for disease outbreaks response-case study of the 2013-2014 Somalia Polio outbreak response dashboard. *Pan Afr Med J*. 2017; 27(suppl 3):22. doi:10.11604/pamj.supp.2017.27.3.11062
139. Martinez M, Shukla H, Ahmadzai M, et al. Progress toward poliomyelitis eradication-Afghanistan, January 2017-May 2018. *MMWR Morb Mortal Wkly Rep*. 2018;67(30):833-837. doi:10.15585/mmwr.mm6730a6
140. Ali M, Lopez AL, You YA, et al. The global burden of cholera. *Bull World Health Organ*. 2012;90(3):209-218A. doi:10.2471/blt.11.093427
141. Bakhshi B, Boustanshenas M, Mahmoudi-aznaveh A. Emergence of *Vibrio cholerae* O1 classical biotype in 2012 in Iran. *Lett Appl Microbiol*. 2014;58(2):145-149. doi:10.1111/lam.12167
142. Deen J, Mengel MA, Clemens JD. Epidemiology of cholera. *Vaccine*. 2020;38 Suppl 1:A31-A40. doi:10.1016/j.vaccine.2019.07.078
143. Disease outbreaks in Eastern Mediterranean Region (EMR), January to December 2018. Weekly Epidemiological Monitor. 2018;2018(11):52.
144. Cholera situation in Eastern Mediterranean Region 2017. Weekly epidemiological monitor. 2018;2018(11):27.
145. Rabaan AA. Cholera: an overview with reference to the Yemen epidemic. *Front Med*. 2019;13(2):213-228. doi:10.1007/s11684-018-0631-2
146. Clarke KEN. *Review of the Epidemiology of Diphtheria 2000-2016*. Geneva: World Health Organization; 2016.
147. World Health Organization (WHO). *Global Health Observatory Data Repository (Eastern Mediterranean Region), Diphtheria Reported Cases by Country*. WHO; 2018. http://apps.who.int/gho/data/view.main-emro.1540_41?lang=en.
148. Ceyhan M, Anis S, Htun-Myint L, Pawinski R, Soriano-Gabarró M, Vyse A. Meningococcal disease in the Middle East and North Africa: an important public health consideration that requires further attention. *Int J Infect Dis*. 2012;16(8):e574-582. doi:10.1016/j.ijid.2012.03.011
149. Harrison LH, Pelton SI, Wilder-Smith A, et al. The Global Meningococcal Initiative: recommendations for reducing the global burden of meningococcal disease. *Vaccine*. 2011;29(18):3363-3371. doi:10.1016/j.vaccine.2011.02.058
150. Borrow R, Caugant DA, Ceyhan M, et al. Meningococcal disease in the Middle East and Africa: findings and updates from the Global Meningococcal Initiative. *J Infect*. 2017;75(1):1-11. doi:10.1016/j.jinf.2017.04.007
151. Hausdorff WP, Hajjeh R, Al-Mazrou A, Shibl A, Soriano-Gabarro M. The epidemiology of pneumococcal, meningococcal, and Haemophilus disease in the Middle East and North Africa (MENA) region--current status and needs. *Vaccine*. 2007;25(11):1935-1944. doi:10.1016/j.vaccine.2006.11.018
152. Leimkugel J, Racloz V, da Silva LJ, Pluschke G. Global review of meningococcal disease. A shifting etiology. *Afr J Bacteriol Res*. 2009; 1(1):6-18. doi:10.5897/jbr.9000024
153. Cabanel N, Leclercq A, Chenal-Francisque V, et al. Plague outbreak in Libya, 2009, unrelated to plague in Algeria. *Emerg Infect Dis*. 2013; 19(2):230-236. doi:10.3201/eid1902.121031
154. Tarantola A, Mollet T, Gueguen J, Barboza P, Bertherat E. Plague outbreak in the Libyan Arab Jamahiriya. *Euro Surveill*. 2009;14(26):19258.
155. Malek MA, Bitam I, Drancourt M. Plague in Arab Maghreb, 1940-2015: a review. *Front Public Health*. 2016;4:112. doi:10.3389/fpubh.2016.00112
156. Esamaeili S, Azadmanesh K, Naddaf SR, Rajerison M, Carniel E, Mostafavi E. Serologic survey of plague in animals, Western Iran. *Emerg Infect Dis*. 2013;19(9):1549-1551. doi:10.3201/eid1909.121829
157. Hashemi Shahraki A, Carniel E, Mostafavi E. Plague in Iran: its history and current status. *Epidemiol Health*. 2016;38:e2016033. doi:10.4178/epih.e2016033
158. Esmaeili S, Naddaf SR, Pourhossein B, et al. Seroprevalence of brucellosis, leptospirosis, and Q fever among butchers and slaughterhouse workers in south-eastern Iran. *PLoS One*. 2016;11(1):e0144953. doi:10.1371/journal.pone.0144953
159. Esmaeili S, Golzar F, Ayubi E, Naghili B, Mostafavi E. Acute Q fever in febrile patients in northwestern of Iran. *PLoS Negl Trop Dis*. 2017; 11(4):e0005535. doi:10.1371/journal.pntd.0005535
160. Bailey MS, Trinick TR, Dunbar JA, et al. Undifferentiated febrile illnesses amongst British troops in Helmand, Afghanistan. *J R Army Med Corps*. 2011;157(2):150-155. doi:10.1136/jramc-157-02-05
161. Almogren A, Shakoor Z, Hasanato R, Adam MH. Q fever: a neglected zoonosis in Saudi Arabia. *Ann Saudi Med*. 2013;33(5):464-468. doi:10.5144/0256-4947.2013.464
162. Grace D, Mutua F, Ochungo P, et al. *Mapping of Poverty and Likely Zoonoses Hotspots*. Nairobi, Kenya: Department for International Development; 2012.

163. Vanderburg S, Rubach MP, Halliday JE, Cleaveland S, Reddy EA, Crump JA. Epidemiology of *Coxiella burnetii* infection in Africa: a OneHealth systematic review. *PLoS Negl Trop Dis*. 2014;8(4):e2787. doi:10.1371/journal.pntd.0002787
164. Esmaeili S, Gooya MM, Shirzadi MR, et al. Seroepidemiological survey of tularemia among different groups in western Iran. *Int J Infect Dis*. 2014;18:27-31. doi:10.1016/j.ijid.2013.08.013
165. Hepburn MJ, Simpson AJ. Tularemia: current diagnosis and treatment options. *Expert Rev Anti Infect Ther*. 2008;6(2):231-240. doi:10.1586/14787210.6.2.231
166. Rohani M, Mohsenpour B, Ghasemi A, et al. A case report of human tularemia from Iran. *Iran J Microbiol*. 2018;10(4):250-253.
167. Mostafavi E, Shahraki AH, Japoni-Nejad A, et al. A field study of plague and tularemia in rodents, Western Iran. *Vector Borne Zoonotic Dis*. 2017;17(4):247-253. doi:10.1089/vbz.2016.2053
168. Montagna M, Chouaia B, Pella F, et al. Screening for bacterial DNA in the hard tick *Hyalomma marginatum* (Ixodidae) from Socotra Island (Yemen): detection of *Francisella*-like endosymbiont. *J Entomol Acarol Res*. 2012;44(3):e13. doi:10.4081/jear.2012.e13
169. Ghoneim NH, Abdel-Moein KA, Zaher HM. Molecular detection of *Francisella* spp. among ticks attached to camels in Egypt. *Vector Borne Zoonotic Dis*. 2017;17(6):384-387. doi:10.1089/vbz.2016.2100
170. Alvar J, Vélez ID, Bern C, et al. Leishmaniasis worldwide and global estimates of its incidence. *PLoS One*. 2012;7(5):e35671. doi:10.1371/journal.pone.0035671
171. Piroozi B, Moradi G, Alinia C, et al. Incidence, burden, and trend of cutaneous leishmaniasis over four decades in Iran. *Iran J Public Health*. 2019;48(Suppl 1):28-35.
172. World Health Organization (WHO). *Leishmaniasis*. WHO; 2018. https://www.who.int/news-room/fact-sheets/detail/leishmaniasis. Accessed December 2018, 2018.
173. Rassi Y, Javadian E, Nadim A, et al. Phlebotomus perfiliewi transcaucasicus, a vector of Leishmania infantum in northwestern Iran. *J Med Entomol*. 2009;46(5):1094-1098. doi:10.1603/033.046.0516
174. AlSamarai AM, AlObaidi HS. Cutaneous leishmaniasis in Iraq. *J Infect Dev Ctries*. 2009;3(2):123-129. doi:10.3855/jidc.59
175. Khatri ML, Di Muccio T, Fiorentino E, Gramiccia M. Ongoing outbreak of cutaneous leishmaniasis in northwestern Yemen: clinicoepidemiologic, geographic, and taxonomic study. *Int J Dermatol*. 2016;55(11):1210-1218. doi:10.1111/ijd.13310
176. Aoun K, Bouratbine A. Cutaneous leishmaniasis in North Africa: a review. *Parasite*. 2014;21:14. doi:10.1051/parasite/2014014
177. Ali A, Ur Rehman T, Qureshi NA, Ur Rahman H. New endemic focus of cutaneous leishmaniasis in Pakistan and future epidemics threats. *Asian Pac J Trop Dis*. 2016;6(2):155-159. doi:10.1016/S2222-1808(15)61003-9
178. Khalil MI, Bahnass MM, Abdallah MIM. Epidemiological and serological study of leishmaniasis in Najran Region, Saudi Arabia. *J Biol Life Sci*. 2017;8(1):59-71. doi:10.5296/jbls.v8i1.10793
179. Al-Salem WS, Pigott DM, Subramaniam K, et al. Cutaneous leishmaniasis and conflict in Syria. *Emerg Infect Dis*. 2016;22(5):931-933. doi:10.3201/eid2205.160042
180. Rehman K, Walochnik J, Mischlinger J, Alassil B, Allan R, Ramharter M. Leishmaniasis in northern Syria during civil war. *Emerg Infect Dis*. 2018;24(11):1973-1981. doi:10.3201/eid2411.172146
181. Du R, Hotez PJ, Al-Salem WS, Acosta-Serrano A. Old world cutaneous leishmaniasis and refugee crises in the Middle East and North Africa. *PLoS Negl Trop Dis*. 2016;10(5):e0004545. doi:10.1371/journal.pntd.0004545
182. ProMED-mail. Leishmaniasis, cutaneous - Libya: (MR), 2018; 13 April: 20180413.5742538. http://www.promedmail.org. Accessed April 10, 2018.
183. Buliva E, Elhakim M, Tran Minh NN, et al. Emerging and reemerging diseases in the World Health Organization (WHO) Eastern Mediterranean Region-progress, challenges, and WHO initiatives. *Front Public Health*. 2017;5:276. doi:10.3389/fpubh.2017.00276
184. World Health Organization (WHO). *Summary Report on the Intercountry Meeting on the Strategic Framework for Prevention and Control of Emerging and Epidemic-Prone Diseases in the Eastern Mediterranean Region, Amman, Jordan 16-19 December 2018*. World Health Organization. Regional Office for the Eastern Mediterranean;2019.
185. WHO Regional Office for the Eastern Mediterranean. Strategic framework for the prevention and control of emerging and Epidemic-Prone diseases in the Eastern Mediterranean Region. WHO Regional Office for the Eastern Mediterranean; 2019.
186. Annual disease outbreak reports, Infectious disease outbreaks reported in the Eastern Mediterranean Region in 2016, 2017, and 2018. http://www.emro.who.int/pandemic-epidemic-diseases/information-resources/annual-disease-outbreak-reports.html.
187. Federspiel F, Ali M. The cholera outbreak in Yemen: lessons learned and way forward. *BMC Public Health*. 2018;18(1):1338. doi:10.1186/s12889-018-6227-6
188. Aungkulanon S, McCarron M, Lertiendumrong J, Olsen SJ, Bundhamcharoen K. Infectious disease mortality rates, Thailand, 1958-2009. *Emerg Infect Dis*. 2012;18(11):1794-1801. doi:10.3201/eid1811.120637
189. Christou L. The global burden of bacterial and viral zoonotic infections. *Clin Microbiol Infect*. 2011;17(3):326-330. doi:10.1111/j.1469-0691.2010.03441.x
190. WHO Regional Office for the Eastern Mediterranean, Implementation of the IHR 2005 in the Region with focus on Ebola virus diseases. *East Mediterr Health J*. 2015;21(10):773-775.
191. Milinovich GJ, Williams GM, Clements AC, Hu W. Internet-based surveillance systems for monitoring emerging infectious diseases. *Lancet Infect Dis*. 2014;14(2):160-168. doi:10.1016/s1473-3099(13)70244-5
192. Brownstein JS, Freifeld CC, Madoff LC. Digital disease detection--harnessing the Web for public health surveillance. *N Engl J Med*. 2009;360(21):2153-2155. doi:10.1056/NEJMp0900702
193. Seimenis A, Battelli G. Main challenges in the control of zoonoses and related foodborne diseases in the South Mediterranean and Middle East region. *Vet Ital*. 2018;54(2):97-106. doi:10.12834/VetIt.1340.7765.1
194. Mahrous H, Redi N, Nguyen TMN, Al Awaidy S, Mostafavi E, Samhouri D. One Health operational framework for action for the Eastern Mediterranean Region, focusing on zoonotic diseases. *East Mediterr Health J*. 2020;26(6):720-725. doi:10.26719/emhj.20.017
195. Bandura A. The social and policy impact of social cognitive theory. In: Mark MM, Donaldson SI, Campbell B, eds. *Social Psychology and Evaluation*. The Guilford Press; 2011:33-70.
196. Alvar J, Vélez ID, Bern C, et al. Leishmaniasis worldwide and global estimates of its incidence. *PLoS One*. 2012;7(5):e35671. doi:10.1371/journal.pone.0035671
197. Almogren A, Shakoor Z, Hasanato R, Adam MH. Q fever: a neglected zoonosis in Saudi Arabia. *Ann Saudi Med*. 2013;33(5):464-468. doi:10.5144/0256-4947.2013.464
198. Zargar A, Maurin M, Mostafavi E. Tularemia, a re-emerging infectious disease in Iran and neighboring countrie. *Epidemiol Health*. 2015;37:e2015011. doi:10.4178/epih/e2015011