International Journal of Social Sciences and Humanities Invention 11(01): 8084-8091, 2024
DOI: 10.18535/ijsshi/v11i01.02
ISSN: 2349-2031
https://valleyinternational.net/index.php/theijsshi

Could Climate Crisis Lead to Novel Pandemics?

Özcan DEVECİ

Infectious Diseases and Clinical Microbiology Specialist Political Science and International Relations Graduate Student Genesis Hospital, Diyarbakir, Turkey

Abstract:

Climate, an integral part of life, varies by region. Climate change and deterioration could lead to significant problems. The Industrial Revolution introduced anthropogenic factors in climate change for the first time in the 19th century. Due to the increase in energy requirements, large volumes of greenhouse gases were released into the atmosphere due to the utilization of fossil fuels such as coal, natural gas and oil. The Industrial Revolution led to rapid climate change and environmental problems. The consequences of these problems are felt in our age. The most affected area is human health by the climate crisis. Its effect on health could be direct or indirect. Infectious diseases that spread globally, crossing both international and intercontinental borders, are described as pandemics. Today, infectious diseases continue to be the most common cause of death in developed countries.Population growth, unplanned urbanization, consumption of unhealthy industrial food items, high exposure toradiation, air pollution and climate change play a role in the development of pandemics. It was reported that climate change altered intra-species interaction and increased the risk of infection. Nations should adopt various measures to mitigate the effects of climate change to preserve public health and minimize human loss or health risks. The present study aimed to determine whether we should expect novel pandemics due to the climate crisis induced by climate change. Thus, studies on the issue were reviewed and the findings are discussed in the present study.

Introduction

Infectious diseases are as old as humans. The first human lived in Africa about 2.5 million years ago. Several fossilswereidentifiednear the Olduvai Gorge and Lake Turkana in southern Africa, evidencing that the origin of the Homo species was Africa (1-4). To survive, first humans ate animal, insect, or plant carcasses. Then, as they developed certain tools, they started to gather and hunt simultaneously.Hunter-gatherer life form dates back 10 thousand years. Humans only settled after the agricultural revolution. The transition to settled life induced several radical changes. These included significant changes in habits and nutritional culture. The transition to the settled life was a milestone in human history. Settlement, trade of agricultural products, and establishment of markets led to several health problems. Diseases spread easily in marketplaces and evolved into epidemics. During this period, domestication of animals and increased contact with animalsfacilitated the transmission of diseases from animals to humans (5).Climate was described as the average or systematic weather conditions experienced over several years in any region of the earth, and the synthesis of weather conditions in a certain area, defined by long-term statistics such as variations and averages of atmospheric elements (6). Climate change was described as "changes in the averages and/or variations in climatic parametersover decades or longer, regardless of the cause." (7) The anthropogenic factors behind theclimate change have become prominentsince the mid-19th century due to higher utilizationof fossil fuels such as coal, oil and natural gas induced by the high energy requirements, high pollution of the atmosphere (8). Climate change has indirect or direct effects on health.Hot and cold waves, extreme temperatures, storms, floods and fires are among the direct effects of climate change. Indirect effects include epidemics, vector-borne, infectious, water- and food-borne, respiratory, allergic diseases and Saharan dust, which were investigated in the present review (9). The word pandemic originated in Greek, meaning all the people.

Pandemic was described as an infectious disease that spread globally across international and intercontinental borders (10). The World Health Organization defined the pandemic as a non-seasonal infectious disease that spread rapidly due to the lack of human immunity to that pathogen. Currently, infectious diseases could still lead to mass deaths even in developed countries. Furthermore, new infectious agents have been identified. Population growth, urban sprawl, consumption of unhealthy industrial food items, increased exposure to radiation, air pollution, and climate change play a role in the development of pandemics caused by infectious microorganisms (11). The effects of climate change are multifaceted and variable. Climate change clearly impacts environmental biosecurity, whilesurveillance of infectious diseases requires concurrent analysis of animal-human health, ecological and environmental issues (12).As the world recovers from the impact of the Covid-19 pandemic, another crisis has quickly been knocking on our door. This crisis entails unpredictable consequences of climate change. Several countries fight to control wildfires, rebuild roads and homes damaged by floods, and learn to survive in a warmer and more dangerous world due to the climate crisis. However, anoverlooked threat is the development of novel infectious diseases and pandemics due to climate change (13). A comprehensive meta-analysis demonstrated that the current climate crisis could aggravate more than 50% of known human

pathogens(14).Experts reported that there was no evidence as to whether the climate change affected the rapid spread of Coronavirus. However, it was also reported that climate change altered intra-species interaction and increasedinfection risks. Since the world warms due to the climate change, creatures that normally live on land and sea have been migrating towards the poles, where they have never lived before, due to the increasing temperatures,contacting the species that they never contacted before, transmitting pathogens to these species (15).

The present study aimed to investigate whether there will be novel pandemics due to climate change.

Thus, initially, the main concepts such as climate, climate change and pandemic are discussed in the following sections. Particularly, the concept of pandemic is discussed based on historical background and significant historical pandemics that affected the human race.

Then, the possible correlation between the Covid-19 pandemic and climate change is discussed to investigate whether the climate crisis, acurrent global problem, would lead to new pandemics.

The study was based on the literature, data collected from relevant international organizations, and my observations as an infectious disease specialist.

What is climate?

Climate entails the averagesand the frequencyof the weather events observed over a long period of time, the peak values in temporal changes, and all variations in these parameters (16). A suitable climate and sufficient water resources are prerequisites for human life on earth. The chemical composition of the atmosphere is important for living beings. Atmospheric chemistry changes with time. The natural climate change that started millions of years ago have produced the clean air and freshwater resources that are currently available.If there had been no climate change since the beginning, it would not be possible for living things to exist on Earth (17). The natural climate changes also led to the generation of subterranean resources such as oil, coal and natural gas. Current studies have scientifically proven that the deserts where oil deposits are located were forests and green fields millions of years ago. Furthermore, climate change led people to migrate to areas where water resources were availablefor survival (17).

Climate change

According to the United Nations Framework Convention on Climate Change, changes induced by anthropogenic activities that directly or indirectly disrupt the composition of the global atmosphere, in addition to natural climate change observed over a comparable time, were defined as climate change (6). Climate change could beinduced by solar energy reflections, the earth's orbit, atmospheric components, atmospheric albedo, volcanic ashes and cloud cover. All these factors could increase the impact of greenhouse gases. Warming of the earth could also lead to climate change. An increase inearth temperature leads to further accumulation of the greenhouse gases in the atmosphere. The cause of global warming was the abnormal accumulation of greenhouse gases in the atmosphere.Because changes in greenhouse gas concentrations in the atmosphere also altersatmospheric gas concentrations. Thus, the atmosphere, hydrosphere and lithosphere that affect the climatedeteriorate, changing the climate (6). Climate change was initially considered an environmental problem; however, recent studies demonstrated that its impact was not only environmental but more comprehensive. Because climate change does not only change the temperature and precipitation, but also affects social and economic life. Thus, the impact, causes and the consequences of the climate change is not only scientific but also social and economic (6).

Climate change also led to health risks. Mortality and spread of infectious diseases have increased due to high temperatures (6).

The correlation between climate change and the spread of pathogens

According to the director of Harvard University Center for Climate, Health and the Global Environment, Dr. Aaron Bernstein, although there is no evidence that climate change had affected the coronavirus pandemic, climate change could increase infectious disease risks since it alters our relationship with other species. Global warming would forceterrestrial and aquatic species to migrate towards the poles due to extreme heat. These migrations would lead to contact between the species that normally do not contact with each other. This would lead to the transmission ofthe pathogens to new species. Loss of habitat due to climate change would also lead to animal migrations and contact with new species (15). Climate change would also affect environmental biosecurity. Thus, monitoring infectious diseases, animal-human health, ecology, and environmental issues should be addressed with a holistic approach (18).Infectious diseases affect the ecology of hosts, vectors, and pathogens. Vibrio cholerae and Yersinia pestis are well-studied examples of predictive waterborne and zoonotic diseasemodeling (19, 20). The endemic locations of infectious diseases that could be transmitted to humans by non-human vectors could change due to climate change. These changes due to global warming would increase and decrease the disease prevalence regions, potentially affecting the survival of the vectors (17).A recent study suggested that climate change would increase the likelihood of epidemics induced by animal-to-human transmissions in the future (21). It was reported that at least 10,000 viral species could infect humans, the vast majority of which currently infect only wild mammals (22, 23). However, changes in climate and land use would lead to the transmission of viruses to certain geographically isolated wildlife species (24, 25). Studies predicted that even global warming would remain below two degrees Celsius by 2070, infections by species with a high transmission potential to humans would significantly increase. Most intra-species transmissionswould be a "dead end" for the viruses. However, those that would mutate and manage to find new hosts could be quite

dangerous (26).Animal species would often migrate to residential or agricultural areas as they escape sweltering temperatures and other effects of climate change. Thus, the unprecedented interactions between these species wouldlead to transmission of pathogens, eventually infecting humans (27). The epidemics such as Ebola, HIV, bird flu, SARS, and most likely Covid-19 were induced bywildlife viruses. It was reported that rapid global warming, deadlier and more contagious pandemics could be on the horizon (27).

Pandemics

Pandemics areglobal epidemicsthat affect masses (28). According to the World Health Organization (WHO)definition, an epidemic could be considered a pandemic when three conditions are observed:

1. Spread of a novel disease,
2. Ability of the pathogen to infect other individuals, leading to dangerous outcomes,
3. Continuous and easy transmission of the pathogen.

The mere fact that a disease or a health condition is prevalent and deadlyacross a significant population is not sufficient to describe the case as a pandemic. The disease should also be transmitted among individuals. For example, although cancer is the leading cause of human death, it could not be considered a pandemic since it is not contagious.
Several pandemics have been recorded throughout history. These were mostly due to anthropogenic destruction of the nature, the decrease in clean water resources, and changes in settlement patterns (29).

Black Plague (1347 Plague Pandemic)

Severalpandemicsthat changed the course of history have been recorded in Europe. It was argued that the Roman Empire collapsed due to the epidemics during the Middle Ages (30). The Plague recorded in the Middle Ages was reported to be caused by the increase in fertility rate in the villages. Despite the increasing population, people ignored hygiene. Even the church and Christian clergy accepted uncleanliness as holy (31). To feed the growing population in Europe, individuals tried to improve agricultural production, drain the swamps, and open new agricultural areas by cutting down the trees in forests. Thus, nature wasdestroyed, and lives became difficult due to the changes in the climate. The crops were frozen, and productivity decreased (32).Human mobility was also effective in the spread of the plague. In the 1330s, the plague spread rapidly in Europe and Asia as the Mongols migrated to escape climatic changes. Fleas that carried the pathogen first spread to China and then to Europe via the trade routes (33). Since Europe hadadequateconditions for the spread of the disease, it spread rapidly and killed half of the infected population. The disease was called black death since the cadavers turnedpurple-blackwithin a short time after death (34).

Cholera Pandemic (1817)

Cholera is an intestinal infection induced by certain strains of the 'vibrio cholerae'bacteria (35,36). The disease was first observed in the Indian Ocean and Asia in 1817. It later spread globally. The disease, which was recorded in the Ottoman Empire in 1881, led to several deaths during the Balkan wars (37). Cholera has been endemic in India since ancient times (38). This was due to the unhygienic bathing conditions in the sacred Ganges River. Furthermore, the climate of the region led to the rapid spread of the bacterium (39). Westward trade routes and the colonization of the region by the British led to further spread of cholera to Europe (39). Later, the disease affected all regions between Bengal and Nepal, Africa, Ceylon, Southeast Asia and Japan, namely all regions aroundthe British trade routes (40).

Spanish Flu

Negative factors such as population growth, malnutrition, mass movements, lack of hygiene, access to health services, poverty and war are among the most important causes of pandemics (41). Opinions differ about the origin of the Spanish flu. One hypothesis argued that it first broke out in Guangdong, China.Flu outbreaks are quite common in China. It was reported that the Spanish flu spread to Europe through trade ports (42). Another view argued that the Spanish flu was induced by the supply chain for World War I requirements was originated in colonies (42). The H1N1 virus that causes the Spanish flu changed to adapt to the human body and became more lethal. Spanish flue spread in three waves. The disease was initially identified in March 1918, disappeared during the summer, and reappeared in 1919 (43). After the First World War, the flu pandemic slowed down as soldiers returned to their homes. Due to the decrease in human mobility, the flu pandemic disappeared over time (44).

Hong Kong Flu(1968)

Hong Kong flu outbreak was caused by a virus that was a combination of several flu viruses. It was called Hong Kong flue since it was first identified in that city. It affected mostly senior citizens older than 65. One million people lost their lives in the outbreak (29).

Other Pandemics

The 2000 SARS pandemic was also first identified in Hong Kong. The disease spread globally in 2002 and 2003 and killed 775 individuals. Swine Influenza, also known as the swine flu, first appeared in Mexico in 2009 and spread globally, killing 18,500

people. It was called swine flu since the pathogen wassimilar to the virus identified in pigs. The disease disappeared after the development of vaccines and antivirals (29).

Coronavirus, Covid-19 (2019)

The disease was first identified in Wuhan, China, on December 1, 2019. In 2020, it spread globally, especially in Europe and America (29). It was suggested that the COVID-19 pandemic originated at a live animal and aquaculture market in Wuhan, China, where wild animals are sold (45). The pandemic, which was initially thought to be short-lived and regress after the measures, continued unabated. This was due to the fact that it was a pandemic and observed in every continent and country (46). According to some, the climate crisis and the Covid-19 pandemic were not only similar, but different manifestations of the same global ecological problem (47). As the Covid-19 epidemic became a pandemic and began to spread in the USA in March, science historian Naomi Oreskes, who works on climate change denialism, stated the following: "First, the existence of the pandemic will be denied, which is a problem in itself, followed by the denial of its seriousness.Then, it will be argued that it isa difficult and expensive problem. It will also be argued that the proposed solutions would threaten our freedoms" (48). Oreskes established a correlation between the climate crisis and the pandemic. The present study aimed to discuss future pandemics that the climate crisis could cause, rather than the similarity between the climate crisis and the Covid-19 pandemic.

Discussion

Theterm "global crisis" has been used for a while to describe climate change when the Covid-19 pandemic began to affect the world and extraordinary measures such as lockdowns, travel restrictions and mandatory testing were introduced. Although the term climate crisis has been used for a long time, climate scientists and activists began to refer to climate change as climate crisis boldly after the speech by Greta Thunberg, a climate activist, at the Davos World Economic Forum in January 2019 (49). The pandemic and the climate crisis were widely associatedduring the first half of 2020. We were supposed to overcome both. However, within a short time, we got used to the pandemic, just like the climate crisis. We began to exhibit the same indifference to both. To prevent new pandemics, we need to change our attitude towards nature, set limits, and ban trade of wild animals(49).Anthropogenic climate change would have significant effects on human health, leading to the migration of humans and infectious diseases. Throughout human history, human mobility has mainly been an adaptive response to variations in environmental and climatic conditions (50). Epidemiological studies have identified health risks associated with extreme temperature changes, climate-induced natural disasters, changing crop yields and water supply. However, infectious diseases have also been determined as factors. The present study findings indicated that environmental support systems for sustainable biological health and human security have been weakening or depleting (51, 52).

The climate crisis could affect the spread of oandemics through various ways:

Increase in pandemic incidence due to human migration

Infectious diseases are affected by migration. Both international and domestic migration induced by the climate crisis exposes migrants to infection in the regions they migrate to. Furthermore, these people also carry infection agents during movement to the new settlements, which alters the distribution and incidences of infectious diseases (53, 54). Prior immunity of a population to certain infectious diseases is a significant modulator of risks for both immigrants and host populations (55). Migration induced by the climate crisis would potentially expose migrants to endemic diseases for which they have limited immunity or those on which they lack socio-cultural experience (56, 57).Malaria is a good example for these diseases. Malaria is commonly observed among immigrants that migrated to theregions where malaria is endemic (58). On the contrary, immigrants could also carry tuberculosis, hepatitis B and sexually transmitted microorganisms to target regions (53, 54). Infectious disease risks also have social determinants associated with working and living conditions and healthcare behavior, including immigrants' access to health services (53).

Pandemics Induced by Natural Disasters

The most common infectious diseases induced by natural disasters include diarrhea, measles, meningitis, acute respiratory infections, tuberculosis, and malaria (59, 60). Epidemic diseases such as influenza A (H1N1) are a concern in crowded campsthat often include malnourished populations(61). Overcrowding and poor hygiene in migrant camps led to intestinal disease outbreaks such as cholera and shigellosis. In September 2012, a cholera epidemic was observed simultaneously with an acute Hepatitis E outbreak in Dadaab, the world's largest refugee camp in Kenya (62). New infectious diseases introduced by immigrants to host populations could include intestinal parasites and multidrug-resistant malaria (63). Furthermore, several poor urban communities live in high-risk areas for the adverse effects of climate change, including lack of freshwater, rise of sea level, flooding and high infectious disease incidence (64, 65).For example, in Bangladesh, poor rural families have migrated to large and crowded Dhaka slums due to tidal flooding and river bank erosionin recent years. This migration poseddiarrhea, dengue fever and skin infection risks. A recent model predicted that the risk of dengue transmission would extend to 2100in Dhaka. Annual dengue fever incidencewould increase 2-fold with a 1°C mean temperature increase, 7-fold with a 2°C mean increase by 2100,and about 40-fold with a 3.3°C mean increasein Dhaka (66). Thus, climate-induced migration to poor urban areas could expose populations to infectious diseases, which would increase further with climate change.Resettlement of communities has affected infectious disease

dynamics. Due to resettlement in marginal agricultural environments, individuals were exposed to infectious diseases (e.g. schistosomiasis) while trying to make a living with agriculture and livestock breeding (67). Climate change would significantly determine the scale and nature of migration in the next decades (68). Infectious diseases in humans and animals have played a significant role in history. Plague epidemics were reported in Rome (2nd century BC) and Athens (5th century BC) in the bible. The Black Death epidemic that hit Europe in the 14th century destroyed one-third to one-half of the European population (69).
Climate crisis is expected to lead to several vector-borne epidemics.

Certain Expected Pandemics Due to the Climate Crisis

Sin Nombre virusis a Hanta virus. It was transmitted to humans by deer mice via direct contact. It could also be transmitted indirectly through mice droppings. The virus leads to the rare Hantavirus pulmonary syndrome (HPS). Although it is rare, the mortality is 40% in HPS. In 1993, an HPS outbreak was witnessed in the "Four Corners" region of the southwestern United States. The cause of the epidemic was the heavy snow during the El Niño winter and the abundance of vegetation transported by the spring runoff and excessive rainfall, which led to an increase in the related vector population (70). The 1993 epidemic, which was a classic example of the correlaion between the climate crisis and infectious diseases, was also significant since a novel PCR technology was employed to identify an unknown infectious disease for the first time (71). Thus, public health authorities started to regularly employ climate data to predict rodent populations and possible hantavirus outbreaks (12).
Powassan virusis a rare disease spread by Ixodes scapularis ticks. Survivors could suffer fromneurological sequelae in the long run, and the virus is often fatal(72). Climate modelsdeveloped in the United States predicted that the Ixodes scapularis tickswould move westward and northward in the future (73). These movementswould lead to an increase in the incidence of the disease caused by the Powassan virus in new residential areas.
Schistosomiasis: In 2008, Utzingeret al. published a report on the potential impact of climate change on schistosomiasis transmission in China. The models based on estimated temperature ranges where schistosomes could develop within the snail predicted that schistosome transmission to currently non-endemic areas would increase due to rising temperatures (74). Recently, an update was published and confirmed earlier predictions that additional areas would be affected by the transmission. In another study, De Leo et al.published similar predictions in Africa, and determined the regions where S. haematobium and S. mansoniincidences would increase or decrease due to climate change (75).
Malariais an infection induced by Plasmodium species. Female Anopheles mosquitoes carry and transmit this parasite. Plasmodium vivax is prevalent in Southeast Asia and the Pacific, and P.falciparum is prevalent in Africa, Southeast Asia and the Western Pacific (76). Climate change factors such as extreme temperatures, humidity, wind and heavy rainfall could affect the distribution and abundance of vectors that are important for plasmodium. Furthermore, climate change has various effects on other vectors such as Culex, the West Nile Fever pathogen (77). Increased precipitation wouldenlarge the distribution areas of mosquitoes and extend the transmission season (78). However, although malaria transmission is sensitive to climate like other infections, it is a complex disease and changes in transmission could not be attributed solely to climate (79, 80).
Valley fever:Valley fever is the common name for Coccidioidomycosis, a flu-like disease caused by the pathogenic Coccidioides sppfungus. The disease is endemic to the southwestern United States. Coccidioidomycosis epidemics generally follow rains followed by dry periods (71). The fungus grows during moist periods. When the soil dries, the disease spreads easily via the inhalation of the spores in dust clouds. A recent model predicted that a high global warming scenario could make the disease endemic in 5 states in the Northwestern USA, increasing the incidence by 50% (81). It is uncertain whether all these scenarios would come true. But the disease has recently spread to Washington State. As global warming continues, at least some of these scenarioscould be possible (82).
Weather events caused or exacerbated by climate change often coincide with an increase in disease vector activities. For instance, floods are among the most devastating disasters induced by climate change in terms of physical damages and mobilization of key disease vectors such as mosquitoes. Effective forecasting and monitoring of these weather events are complex and entail consideration of several factors. However, climate modelsthat employ artificial intelligence technology could effectively predict floods and monitor their consequences (83).

Conclusion

There is ample evidence that climate change has affected pathogen-vector-host systems, particularly in temperate, circumpolar, and high-altitude regions in the tropics. Scientists demonstrated the global spread of vectors and the pathogens they carry. If humans fail to mitigate the effects of or adapt to climate change, and the increase in drug and pesticide continues, the likelihood of similar pandemicswould increase in the future. The number of novel vector-borne outbreaks has increased in recent years due to socioeconomic and environmental factors, global warming and climate change. Even the most optimistic predictions estimated that the impact of climate change will significantly change within decades or years rather than centuries.These variations will, in turn, would lead to ever-changing public health problems, due in part to higher data collection capabilities, leading to a global health crisis. Climate change clearly affects infectious diseases and biosecurity in general. Thus, bio-surveillance, animal-human-plant health, ecology and environmental issues should be further analyzed. Nobody wants to own the responsibility of climate change control. Everyone should contribute to these efforts globally. On the other hand, the Covid-19 pandemic led to intergovernmental

and multinational cooperation in an urgent and challenging crisis.However, climate change is so complex that it is quite difficult to determine future challenges. Nor they could be approached with existing tools. The World Health Organization (WHO) is the most prominent organization involved in the collection of global health data. The organization's "SCORE" system helps member states to improve health data collection and distribution. Diseases induced by the climate crisis could significantly affect public health. Countries allocatedsignificant budgets to reduce these negative effects. Measures and adaptation effortscould minimize human loss and health risks. Several pandemics have occurred throughout human history. Post-pandemic crises led to several public health, economic and national security problems. Thus, prevention of the climate crisis would also prevent future pandemics.

References

1. Leakey, R. (1998). İnsanın Kökeni. (Çev. Sinem Gül), Varlık Yayınları.
2. Leakey, R., ve Lewin, R. (1998). Göl insanları / evrim sürecinden bir kesit. (Çev. Füsun Baytok), TÜBİTAK Popüler Bilim Kitapları.
3. Strınger, C. (2011). Theorigin of ourspecies, PenguinBooks.
4. Lewın, R. (2015). Modern insanın kökeni. (Çev. Nurdan Soysal), Say Yayınları.
5. Esen A. (2017). Sıhhî-İ İctimâî Coğrafya Kitaplarına Göre İç Anadolu'da Görülen Salgın Hastalıklar (1922-1926). Ankara Üniversitesi Türk İnkılâp Tarihi Enstitüsü Atatürk Yolu Dergisi. 60: 73-90.
6. https://iklim.gov.tr/sss/temel-kavramlar.
7. (IPPS, 2007).
8. (TKHHÖKP, 2010)
9. Nur, N., Sümer, H. (2012). "Kentleşme, Küresel Isınma ve İklim Değişikliğinin Sağlık Üzerindeki Etkileri". www.erciyestipdergisi.org. (18.05.2020).
10. Özkoçak V, Koç F, Gültekin T. Pandemilere Antropolojik Bakış: Koronavirüs (Covid-19) Örneği. TurkishStudies, 15(2), 1183-1195. https://dx.doi.org/10.29228/TurkishStudies.42679.
11. Singer, M. (2009). PathogensGone Wild? MedicalAnthropologyandthe "SwineFlu" Pandemic. MedicalAnthropology, 28(3): 199–206.
12. Kenneth B. Yeh, Falgunee K. Parekh, IllichMombo , Joseph Leimer , RogerHewson, Gene Olinger , Jeanne M. Fair , Yijun Sun and John Hay. Climatechangeandinfectiousdisease: A prologue on multidisciplinary, cooperationandPredictiveanalytics. Front. PublicHealth, 20 January 2023 Sec. InfectiousDiseases: EpidemiologyandPrevention Volume 11 - 2023 | https://doi.org/10.3389/fpubh.2023.1018293.
13. TULIO DEOLIVEIRA H, HOURIIYAH TEGALLY.Willclimatechangeamplifyepidemicsandgiverisetopandemics? *SCIENCE*25 Aug 2023 Vol 381, Issue 6660 DOI: 10.1126/science.adk4500
14. CamiloMora,TristanMcKenzie, Isabella M. Gaw , Jacqueline M. Dean , HannahvonHammerstein, Tabatha A. Knudson , Renee O. Setter , Charlotte Z. Smith , Kira M. Webster , Jonathan A. Patzand Erik C. Franklin. Overhalf of knownhumanpathogenicdiseases can be aggravatedbyclimatechange. Nature ClimateChange | VOL 12 | September 2022 | 869–875
15. https://www.hsph.harvard.edu/c-change/news/coronavirus-climate-change-an...
16. Murat Türkeş, Klimatoloji ve Meteoroloji, İstanbul, Kriter Yayınları, 2010.
17. Zekâi Şen. ClimateChangeand Türkiye. İklim Dergisi:2020: (1): 1-19.
18. Kenneth B. Y, Falgunee K. P, IllichM , Joseph L, Roger H, Gene O , Jeanne M. F , Yijun S and John H. Climatechangeandinfectiousdisease: A prologue on multidisciplinarycooperationandpredictiveanalytics. Frontiers in PublicHealthPUBLISHED 20 January 2023 DOI 10.3389/fpubh.2023.1018293
19. deConstantinMagny G, Rita RR. Choleraandclimate: A demonstratedrelationship. Trans AmClinClimatolAssoc. (2009) 120:119–28.
20. Han BA, Schmidt JP, Bowden SE, Drake JM. Rodentreservoirs of futurezoonoticdiseases. ProcNatlAcadSci. (2015) 112:7039–44. doi: 10.1073/pnas. 1501598112.
21. Colin J. Carlson, Gregory F. Albery, CoryMerow, Christopher H. Trisos, Casey M. Zipfel, Evan A. Eskew, Kevin J. Olival, NoamRoss , ShwetaBansal. Climatechangeincreasescross-speciesviraltransmission risk. Nature(2022) volume 607,555–562 .
22. Carlson, C. J., Zipfel, C. M., Garnier, R. &Bansal, S. Global estimates of mammalianviralbiodiversityaccountingforhostsharing. *Nat. Ecol. Evol.* 3, 1070–1075 (2019).
23. Olival, K. J. et al. Host andviraltraitspredictzoonoticspilloverfrommammals. *Nature* 546, 646–650 (2017).
24. Hoberg, E. P. &Brooks, D. R. Evolution in action: climatechange, biodiversitydynamicsandemerginginfectiousdisease. *Philos. Trans. R. Soc. B* 370, 20130553 (2015).
25. Morales-Castilla, I. et al. Forecastingparasitesharingunderclimatechange. *Philos. Trans. R. Soc. B* 376, 20200360 (2021).
26. SoleilFoy. ClimateChangewillIncreaseLikelihood of Pandemics. Nature, April 28, 2022.
27. LA Times: *How pandemicsarelinkedtoclimatechange*, May 21, 2022

28. Porta, M. (2008). Dictionary of Epidemiology. Oxford.
29. Ayşe Tekin. TARİHTEN GÜNÜMÜZE EPİDEMİLER, PANDEMİLER ve EKONOMİK SONUÇLARI. Journal of Süleyman Demirel UniversityInstitute of SocialSciencesYear: 2021/2, Number: 40, p. 330-355
30. Lewis, P. (1998). S:63Tıp Tarihi. İstanbul: Khalkedon Yayınları.
31. Nikiforuk, A. (1991). S:57-58: FourthHorseman: A ShortHistory of Epidemics, Plagues, Famine, andOtherSources. Kanada: PenguinGroup.
32. Flinn, M.W. (1987). S:27 Avrupa ve Akdeniz Ülkelerinde Veba, Tarih ve Toplum. İstanbul: İletişim Yayınları.
33. Ziegler, P. 1972 :. 33-34 Veba, Tarih Mecmuası. İstanbul: Hayat Yayınları.
34. Ersoy, T. 1996:84. Tıp, Tarih, Metafor. Ankara: Öteki Yayınevi
35. *Finkelstein, Richard A. (1996). "Cholera, Vibriocholerae O1 and O139, andOtherPathogenicVibrios". Baron, Samuel (Ed.). MedicalMicrobiology (4th bas.). University of Texas MedicalBranch at Galveston.* ISBN 978-0-9631172-1-2. PMID 21413330. NBK8407.
36. "Cholera – Vibriocholeraeinfection Information forPublicHealth&MedicalProfessionals". CentersforDisease Control andPrevention. *6 Ocak 2015. 20 Mart 2015 tarihinde kaynağından* arşivlendi. Erişim tarihi: 17 Mart 2015.
37. Ayar, M. 2007: 30-32. Osmanlı Devleti'nde Kolera. İstanbul: Kitabevi Yayınları.
38. Barua, D. (1992). History of Cholera, Cholera. Ed. D. Baruaand W. B. Greenough. New York.
39. Yaşayanlar, İ. (2015). Sinop, Samsun ve Trabzon'da Kolera Salgınları, Karantina Teşkilatı ve Kamu Sağlığı Hizmetleri (1879-1914). (Basılmamış Doktora Tezi, Uludağ Üniversitesi Sosyal Bilimler Enstitüsü Bursa).
40. McNeill, W. H. (1985). Dünya Tarihi. çev. Alâeddin Şenel, Ankara.
41. Price, S., Andrew T. (2009). Contagionand Chaos: Disease, Ecology, andNational Security in theEra of Globalization. Massachusetts, MIT Publishing.
42. Erkoreka, A. (2009). Origins of Spanish InfluenzaPandemic (1918-1920) andItsRelationtoThe First World War, Journal of MolecularandGeneticMedicine. Aralık, C.3, S.2: 192.
43. Quinn, T. (2008). Flu: A SocialHistory of Influenza, London. New Hollan
44. Pettigrew, E. (1983). TheSilentEnemy: CanadaandThe Deadly Flu of 1918. Saskatchewan. Western Producer PraireBooks.
45. Maron, Dina Fine. 2020. "'Wetmarkets' likelylaunchedthecoronavirus. Here'swhatyouneedtoknow." NationalGeographic. 15 Nisan. https://www.nationalgeographic.com/ animals/2020/04/coronavirus-linked-tochinese-wet-markets/.
46. "WHO CoronavirusDisease (Covid-19)" Dashboard. https://covid19.who.int/.
47. Malm, Andreas. 2020. Corona, Climate, ChronicEmergency: WarCommunism in theTwenty-First Century. London: Verso.
48. Edelmanideas, Gilad. 2020. "TheAnalogyBetween Covid-19 andClimateChange Is EerilyPrecise." Wired. 25 Mart.https://www. wired.com/story/the-analogy-between-covid19-and-climate-change-is-eerily-precise.
49. Şahin Ü. Salgın, iklim Krizi ve Gerçeklik. Salgın, İklim Toplum. Metis Yayınları. 2022. S:152-173.
50. CeliaMcMichael. Climatechange-relatedmigrationandinfectiousdisease. Virulence 6:6, 548--553; August/September 2015;
51. Butler CD, Harley D. Primary, secondaryandtertiaryeffects of eco-climaticchange: themedicalresponse. PostgradMed J 2010; 86:230-4; PMID:20354046; http://dx.doi.org/10.1136/pgmj.2009.082727.
52. McMichael AJ. Globalization, climatechangeandhumanhealth. NEJM 2013; 368:1335-43; PMID:23550671; http://dx.doi.org/10.1056/NEJMra 1109341
53. McMichael C, Barnett J, McMichael AJ. An illwind? Climatechange, migrationandhealth. EnvironHealthPersp 2012; 120(5):646-54; PMID:22266739; http:// dx.doi.org/10.1289/ehp.1104375.
54. Carballo M, Smith C, Pettersson K. Climatechangeanddisplacement: healthchallenges. Forced Migration 2008; 31:32-3.22.
55. Zimmerman C, Kiss L, Hossain M. Migration andHealth: A Framework for 21st Century PolicyMaking. PLoSMed 2011; 8(5):e1001034; PMID:21629681; http://dx.doi.org/10.1371/journal. pmed.1001034.
56. Afolayan AA, Adelekan IO. The role of climaticvariations on migrationandhumanhealth in Africa. Environmentalist 1999; 18(4):213-8; http://dx.doi.org/ 10.1023/A:1006581002775.
57. Bowles DC, Butler CD, Friel S. Climatechangeandhealth in Earth'sfuture. Earth's Fut 2013; 2:60-7.
58. Toole MJ, Waldman RJ. Thepublichealthaspects of complexemergenciesandrefugeesituations. AnnuRevPublicHealth 1997; 18:283-311; PMID:9143721; http://dx.doi.org/10.1146/annurev.publhealth.18.1.283.
59. De Bruijn B. Thelivingconditionsandwell-being of refugees. Geneva: UNDP; 2009.
60. Murray R, Davis J, Burgner D. TheAustralasianSocietyforInfectiousDiseasesguidelinesforthediagnosis, managementandprevention of infections in recentlyarrivedrefugees: an abridgedoutline. Med J Aust 2009; 190(8):421-5; PMID:19374613.
61. Mowafi H. Conflict, displacementandhealth in theMiddle East. GlobPublicHealth 2011; 6(5):472-87; PMID:21590557; http://dx.doi.org/10.1080/174416- 92.2011.570358.
62. Ahmed JA, Moturi A, Spiegel P, Shilperoord M, Burton W, Kassim N, Mohamed A, Ochieng M, Nderitu L, Navarro-Colorado C, et al. Hepatitis E outbreak, dadaabrefugeecamp, Kenya, 2012. EmergInfectDis 2013; 19(6):1010-1; PMID:23735820; http://dx.doi. org/10.3201/eid1906.130275.

63. Palinkas L, Pickwell S, Brandstein K, Clark T, Hill L, Moser RJ, Osman A. Thejourneytowellness: stages of refugeehealthpromotionanddiseaseprevention. J ImmigrHealth 2003; 5(1):19-27; PMID:14512755; http://dx.doi.org/10.1023/A:1021048112073.
64. Harley D, Bi P, Hall G, Swaminathan A, Tong S, Williams C. ClimateChangeandInfectiousDiseases in Australia: FutureProspects, Adaptation Options, andResearchPriorities. Asia Pacific J PubHealth 2011; 23:54S-66S.
65. Huq S, Kovats S, Reid H, Satterthwaite D. Editorial: Reducingriskstocitiesfromdisastersandclimatechange. Environ Urban 2007; 19:3-15; http://dx.doi. org/10.1177/0956247807078058.
66. Banu S, Hu W, Guo Y, Hurst C, Tong S. Projectingtheimpact of climatechange on denguetransmission in Dhaka, Bangladesh. EnvironInt 2014; 63:137-42; PMID:24291765; http://dx.doi.org/10.1016/j.envint. 2013.11.00.
67. Zhou X, Guo J, Wu X. Epidemiology of Schistosomiasis in thePeople'sRepublic of China, 2004. EmergInfectDis 2007; 13(10):1470-6; PMID:18257989; http://dx.doi.org/10.3201/ eid1310.061423.
68. IPCC (Intergovernmental Panel on ClimateChange). Human Security. Contribution of WorkingGroup II totheFifthAssessment Report of theIntergovernmental Panel on ClimateChange. Cambridge, UK: Cambridge UniversityPress; 2014; Chap. 12.
69. McMichael, A.J. 2012. Insightsfrompastmillenniaintoclimaticimpacts on humanhealthandsurvival. Proc. Natl. Acad. Sci. USA 109: 4730–4737.
70. Van Hook CJ. Hantaviruspulmonarysyndrome—the 25th anniversary of theFourCornersoutbreak. EmergInfDis. (2018) 24:2056–60. doi: 10.3201/eid2411.180381.
71. Kolivras KN, Comrie AC. Modelingvalleyfever (coccidioidomycosis) incidence on thebasis of climateconditions. Int J Biometeorol. (2003) 47:87–101. doi: 10.1007/s00484-002-0155-x.
72. Hermance ME, Thangamani S. Powassanvirus: an emergingarbovirus of publichealthconcern in North America. Vector-BorneZoonoticDis. (2017) 17:453– 62. doi: 10.1089/vbz.2017.2110.
73. Alkishe A, Raghavan RK, Peterson AT. Likelygeographicdistributionalshiftsamongmedicallyimportantttickspeciesandtick-associateddiseasesunderclimatechange in North America: a review. Insects. (2021) 12:225. doi: 10.3390/insects12030225.
74. Zhou XN, Yang GJ, Yang K, Wang XH, Hong QB, Sun LP, et al. Potentialimpact of climatechange on schistosomiasistransmission in China. Am J Trop MedHygiene. (2008) 78:188–94. doi: 10.4269/ajtmh.2008.78.188.
75. De Leo GA, Stensgaard AS, Sokolow SH, N'Goran EK, Chamberlin AJ, Yang GJ, et al. Schistosomiasisandclimatechange. BMJ. (2020) 371. doi: 10.1136/bmj.m4324.
76. Ansari HR, Templeton TJ, Subudhi AK, Ramaprasad A, Tang J, Lu F, et al. Genome-scalecomparison of expanded gene families in Plasmodium ovale wallikeriandPlasmodium ovale curtisiwithPlasmodiummalariaeandwithotherPlasmodiumspecies. Int J Parasitol. (2016) 46:685–96. doi: 10.1016/j.ijpara.2016.05.009.
77. El Samra GH. Climatechangeandhumaninfectiousdiseases (Review). Egypt J OccupMed. (2019) 43:33–56. doi: 10.21608/ejom.2019.25106.
78. Tanser FC, Sharp B, Le Sueur D. Potentialeffect of climatechange on malariatransmission in Africa. Lancet. (2003) 362:1792–8. doi: 10.1016/S0140-6736(03)14898-2.
79. Reiter P. Global warmingandmalaria: knowingthehorsebeforehitchingthe cart. Malar J. (2008) 7:S3. doi: 10.1186/1475-2875-7-S1-S3.
80. Gething PW, Smith DL, Patil AP, Tatem AJ, Snow RW, Hay SI, et al. Climatechangeandthe global malariarecession. Nature. (2010) 465:342–5. doi: 10.1038/nature09098.
81. Gorris ME, Treseder KK, Zender CS, Randerson JT. Expansion of coccidioidomycosisendemicregions in the United States in responsetoclimatechange. GeoHealth. (2019) 3:308–27. doi: 10.1029/2019GH000209.
82. Oltean HN, Springer M, Bowers JR, Barnes R, Reid G, Valentine M, et al. Suspectedlocallyacquiredcoccidioidomycosis in human, Spokane, Washington, USA. EmergInfectDis. (2020) 26:606. doi: 10.3201/eid2603.191536.
83. Mosavi A, Ozturk P, Chau K. Floodpredictionusingmachinelearningmodels: literaturereview. Water. (2018) 10:1536. doi: 10.3390/w10111536