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Review Article

Pandemics

Pandemics in Human History: A Study of Origin, Enormity, Mortality Rate and Controlling Strategies

Adya Trisal[1], Bhoomika Pandey[1], Dheeraj Mandloi[2*], Tapesh Sarsodia[2] and Sapna Jain Dabade[3]

[1]*Student, BE III Year Computer Engineering, Institute of Engineering and Technology, Devi Ahilya University, Indore, Madhya Pradesh, India*

[2*]*Faculty, Institute of Engineering and Technology, Devi Ahilya University, Indore, Madhya Pradesh, India, email: dmandloi@ietdavv.edu.in, Mobile: 9407894470*

[3]*Faculty, Department of Applied Science, SAGE University, Indore and Research Scholar at School of Chemical Sciences, Devi Ahilya University, Indore, Madhya Pradesh, India*

Abstract: With the advent of time, the human population has augmented and so have the transmittable diseases, but not every disease can be branded with the title of being a pandemic. A pandemic is principally an outbreak of a disease affecting a significantly large geographical area and marks the destruction of all life forms. Throughout history, mankind has been afflicted with, and endured several pandemics. These pandemics had various underlying impacts on both social as well as the economic aspects of the affected nations. From devastatingly high death toll to economic collapses, a pandemic causes a plethora of unpropitious effects. But sometimes, the aftermath of a pandemic can also have a positive outcome e like breakthroughs in the field of medicine, immunization and antimicrobial cures, the fact that, the concept of a vaccine was conceived as a repercussion of the smallpox pandemic, is the best example to reinforce this statement. In previous research papers different authors have inculcated distinct methodologies and although these papers were structured immaculately, they lack in terms of information as these papers focus on specific diseases and discuss parameters like death rate, mode of transmission etc. pertaining to those particular pandemics only. This paper on the other hand outlines the most prominent and noteworthy outbreaks (in terms of destruction to life, property and economy) and will help the reader to attain a comprehensive and unobstructed idea about the major pandemics, which have occurred throughout the history. It also provides an in-depth understanding about their timeline, origins, mortality rate and coping strategies as well.

Keywords: Pandemic, Outbreaks, Origin, Impact, Mortality Rate, Coping Strategies.

***Corresponding Author**

Dheeraj Mandloi , Faculty, Institute of Engineering and Technology, Devi Ahilya University, Indore, Madhya Pradesh, India

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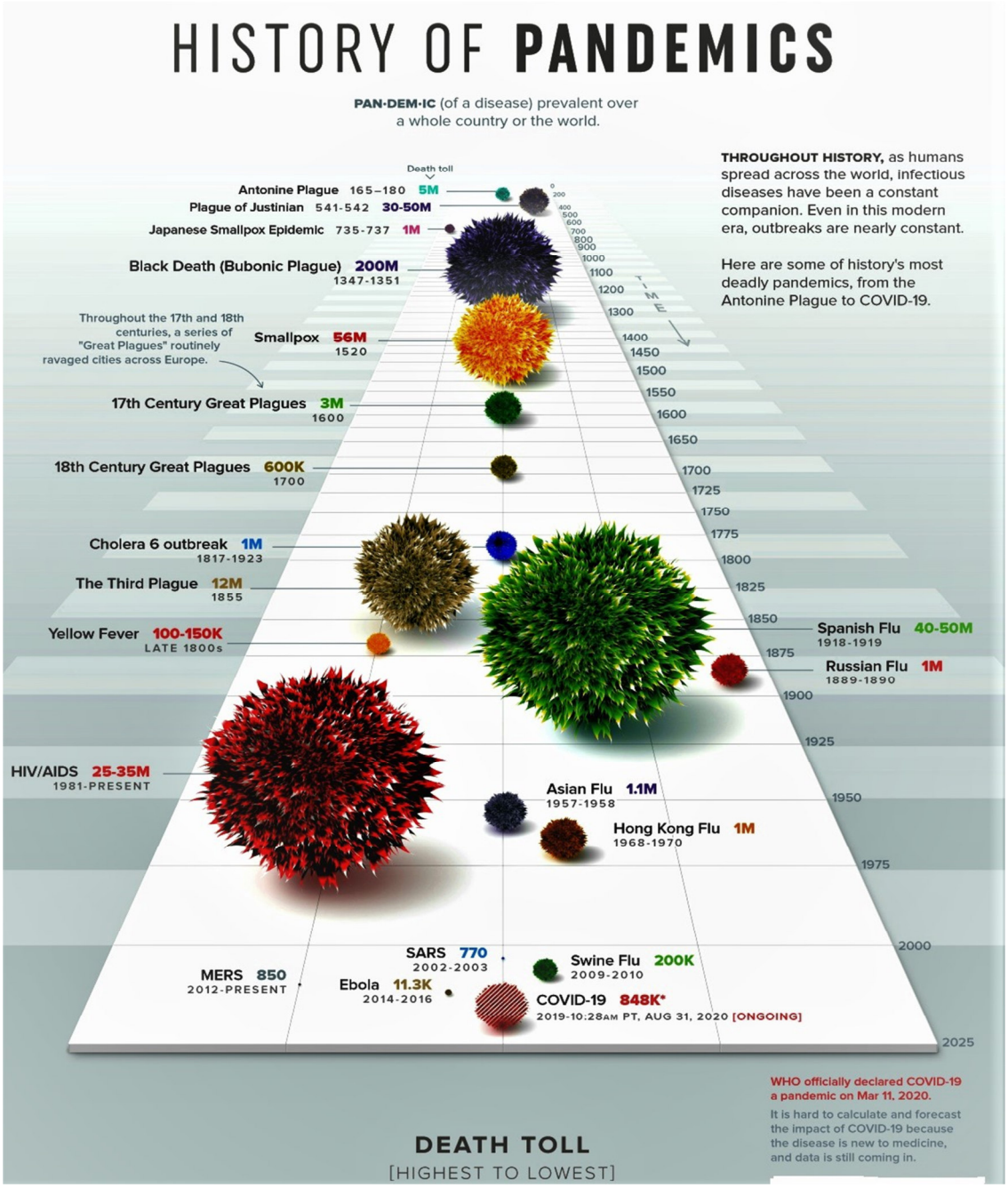
1. INTRODUCTION

As per, World Health Organization (WHO) "a pandemic is a worldwide spread of a new disease. It is essentially an epidemic which spans international borders"[1]. A pandemic, by striking over a gargantuan portion of the society gives rise to several arduous conditions like drop in the tourism sector and trade, economic recession, unemployment and not to mention the mass obliteration of life forms. The human civilization has been plagued by these widespread diseases as early as 3000 BC, some of the most prominent and catastrophic ones (as depicted by figure 1)[2] are as follows: (Plague Of Justinian (541-542 AD), The Black Death (1346-1353 AD),Influenza Pandemic (AsianFlu 1957-1958AD,Spanish Flu1918-1920 AD, Hong Kong Flu 1968-1969 AD and Swine Flu 2009-2010 AD), Smallpox(1350-1980 AD), Cholera (1817AD-PRESENT),HIV/AIDS(1981AD-PRESENT) and the Coronavirus(2019AD-PRESENT).



This modified version of the image gives a comprehensive view of the major and deadliest pandemics which have occurred throughout the history.

Fig 1. Deadliest Pandemics throughout History[2]

2. *LIST OF PANDEMICS*

2.1 JUSTINIAN'S PLAGUE (541-542CE)

During emperor Justinian's reign, the world's deadliest plagues took place, killing approximately 30-50 million people. Though, it last materialized in 750 CE, after 800 years it re-emerged again in the form of Black Death[3].

2.1.1. ORIGIN

The disease-causing microbe Yersinia Pestis allegedly originated in China or northeast India and its primary carriers were black rats. They travelled on the grain ships and

wagons, which were sent to Constantinople as homage to the crown. The grains cartons offered the ideal breeding ground for the fleas and rats, which led to the transmission of the microbes. Egypt was the epicenter of the Justinian plague and after that it proliferated exponentially.

2.1.2 IMPACT AND DEATH TOLL

Mankind was afflicted by the Justinian plague (first pandemic of the bubonic plague) in the sixth century. It caused the death of approximately 30-50 million people, bourgeoning across Asia, North Africa, Arabia, and Europe precipitously. The plague contributed robustly towards the weakening of the Byzantine Empire. It deteriorated both political as well as economic conditions. As the disease propagated all over the Mediterranean, the empire's power to defend itself against the enemies reduced significantly, which made it almost effortless for the Lombards and the Arabs to invade their territory. The economic conditions were no better, most of the trade operations ceased due to the risk of further contamination.

2.1.3 COPING STRATEGIES

Symptoms and Treatment: the symptoms included (but not limited to) swollen lymph nodes, Headache, high fever, Nausea and vomiting. The people who were infected with the disease could be examined by amedical personnel from Alexandria only if they were royalty or belonged to an influential background. The common people were forced to get treated at their houses. These treatments included remedies like cold water baths or some medicinal herbs. None of these home remedies would truly aid in treating the infected, so they were often asked to quarantine in the hospitals and the rate of their survival was poor..

2.2 BLACK DEATH (1346 – 1353)

The Black Death was indisputably one of the most cataclysmic pandemics of all times. 50-60% of the European population was annihilated during the Black Death[4]. In addition to this, it was found that the nature of the plague was recurrent, it continued to strike Europe and the Middle East for the subsequent four centuries, recurring after every decade or two.

2.2.1 ORIGIN

The Black Death proliferated through the Middle East and Europe in the year 1346- 1353.The plague manifested itself yet again between the 14th and 18th centuries known as the Second Plague Pandemic. The root initiate of the plague was the bacterium Yersinia Pestis. It mainly affected the rodents and then was transmitted to humans via fleas or other disease carriers which were usually insects. Although the development of the international trade network boosted the economy, it was also one of the chief reasons, which led to the spread of the plague. This era witnessed an upsurge in the population of Europe, which in turn led to the increase in accumulation of sub standardly treated waste. This accumulated waste created unsanitary conditions, which provided a perfect breeding ground for the bacterium.

2.2.2 IMPACT AND DEATH TOLL

The plague has claimed the lives of roughly 30%-60% of Europe's population and may have reduced the world population from an estimated 475 million to 350–375 million in the 14th century[5]. It took 200 years for Europe's population to replenish[6]. Due to unanticipated diminution of the population, the demand for the daily wage workers increased and so did their wage offer. Although attempts were made to regulate the wages to their previous state (i.e. before the Black Death) but, they were seldom enforced. This era also witnessed the oppression of the Jewish by Europeans. Some Jewish communities were slightly less affected by the pandemic (generally due to their cleanliness and the fact that they were sequestered in ghettos[7]) and were accused by the Europeans of initiating the pandemic by contaminating the water sources(wells).The Black Death caused a lot of devastation but its aftermath also led to various scientific breakthroughs as well. In 1894 scientists discovered the causative microbe and by 1898 the means of its transmission was discovered as well. These discoveries subsequently rippled to cause significant developments in the fields of microbiology, medicines and sanitation.

2.2.3 COPING STRATEGIES

Symptoms and treatments: People who had the disease could remain asymptomatic for a few days. Infected people were afflicted with swollen lymph nodes located at groin area or underarms region, which would mature into blackish-blue lumps. These would fester infections and result in death. Lack of medical knowledge in that era can be one of the major contributors towards the large number of deaths. After the discovery of the causative microbe, effective treatment with the actual medication was started in 1986. The upcoming years saw ameliorationin the treatment and consequently, eradication of the disease.

2.3 INFLUENZA PANDEMIC

The epidemic caused by the influenza virus, which traverses worldwide and infects a massive proportion of the world population can be essentially called an influenza pandemic. Some of the most noteworthy influenza pandemics throughout the history are: The Spanish flu (1918), The Asian flu (1957), The Hong Kong flu (1968) and The H1N1/09 flu pandemic (2009).

2.3.1. ORIGIN

Influenza pandemics manifest when a novel strain of the influenza virus is proliferated amongst humans from animal species like pigs, chickens and ducks. Once these viruses inhabit a human body all it takes is a cough or a sneeze and approximately half a million virus particles can spread to those in the near proximity[8]. These strains remain inviolate by any prior immunity people may have of influenza and can lead to a widespread pandemic. Commercial trade shipments and human travel are the core means of transmission of the viruses all over the world[9].

2.3.2 VARIOUS TYPES, THEIR IMPACTS AND DEATH TOLL

2.3.2.1 SPANISH FLU (1918-1920)

Widely known as the deadly pandemic of 1918. It persisted for almost 3 years from January 1918 to December 1920, afflicting almost 500 million people – about a third of the world's population in that era[10].The death toll was estimated to be 17million-50million, and conceivably as high as 100

million[11]. Due to lack of vaccines to treat this flu strain the residents were ordered to wear masks, and public places like schools, theaters and offices were under lockdown.

2.3.2.2 ASIAN FLU (1957-1958)

In the February of 1957, a new influenza strain (H2N2) which was an amalgamation of avian influenza (from geese) and human influenza[1213], surfaced in East Asia, prompting a pandemic called the Asian flu. It was said to have originated in Guizhou. It was first identified in Singapore (February 1957) and in the month of April it struck Hong Kong as well. By 1957 it reached the coastal cities of the USA. The death toll of the flu was approximated to be around 1.1 million worldwide.

2.3.2.3 HONG KONG FLU (1968–1969)

The Hong Kong flu was caused by a strain of H3N2 virus. It is estimated to kill one million people worldwide [1415].

2.3.2.4 H1N1/09 FLU PANDEMIC (2009–2010)

The first case of the swine flu(A/H1N1) occurred in Mexico in 2009. Observing the rate of transmission of the disease on 11 June 2009, WHO declared it to be the first influenza pandemic of the 21st century. Repercussions of the pandemic resulted in more than 18,000 confirmed deaths[16]. Due to derisory surveillance; the authentic death toll was likely to be much higher than reported. The World Health Organization, has since ascended that approximately 284,500 people were killed by the disease, which is nearly 15 times the number of preliminary recorded deaths [17,18].

2.3.3 COPING STRATEGIES

Development of a potential vaccine can take several years, and even after that it can take 7-9 months to make it readily accessible. It is not possible to generate a vaccine for a virus, which doesn't exist yet. As per the World Health Organization, merely 19 countries are listed as "influenza vaccine manufacturers"[19]. Hence, in this section we will focus on the steps, which can be taken by the general public to stem the transmission of the virus in case of flu pandemic, as solely anticipating the vaccine will not ameliorate the situation. Social distancing, imposing lockdowns, shutting down public institutions (like school, movie theatres etc.), maintaining personal hygiene (washing hands) and respiratory hygiene (covering their mouth and nose while coughing or sneezing) wearing protective gear like masks and gloves, abstaining from travelling to potentially infected areas and avoiding contact with infected people are some of the ways which can curb the augmentation of the viruses to a large extent.

2.4 SMALLPOX

About 10 millennia back, a deadly virus-: *Variola* (causative of smallpox) originated in Africa. It was transmitted through air via nasal/oral droplets i.e., when a person coughed or sneezed. The virus targeted the skin cells, lymph nodes, bone marrow and spleen of the infected person.

2.4.1 ORIGIN

The first smallpox epidemic was afflicted upon the Egyptians in 1350 BC. From Egypt, it was essentially proliferated via the trade. The infected people first developed a fever, which was closely followed by vomiting and skin rashes and scabs. The people who survived this ordeal bore scars throughout their lives.

2.4.2 IMPACT AND DEATH TOLL

With the mortality rate of 30%, the smallpox has annihilated over 300 million people worldwide in the 20th century [2021] and nearly 500 million people in the concluding century of its sustenance[22].Observing the decimation caused by the disease, The British decided to use smallpox as a biological weapon against the French and Native Americans during the period of the French and Indian Wars (1754–1763)[23].This period also saw the rise of several contemporary religious traditions, one of them was worshipping of the smallpox deities. This custom was chiefly followed in India and China.

2.4.3 COPING STRATEGIES

The most primitive method employed to thwart smallpox was injecting a person with variola virus which was usually collected from the scabs of an infected individual (this method is known as variolation), If the procedure was efficacious, the person inoculated would develop immunity against future smallpox pestilence. In the year of 1796, an English physician by the name Edward Jenner found that inoculating a person with the cowpox virus could also induce the resilience to smallpox. This led to the conceiving of the smallpox vaccine. Inoculating a person with cowpox was a much safer alternative because it had no jeopardy of a smallpox transmission, thus making it less pernicious than variolation. In 1980, the World Health Organization declared the global extermination of the disease[24]. The present-day vaccine for smallpox comprises the *vaccinia virus.*

2.5 HIV/AIDS

Human immunodeficiency virus is a type of retrovirus which uses the RNA to infect the $CD4^+$ immune cells. After it enters the target cell, the viral RNA genome converts into DNA. The virus DNA is then assimilated into the cell nucleus[25]. Once amalgamated, the virus may become dormant; this phenomenon allows the virus and its host cell to limit the risk of exposure by the immunity system[26]. Gradually the virus continues to weaken the immune system, and when the $CD4^+$ immune cells count falls below 200, then the person is said to have Acquired Immunodeficiency Syndrome (AIDS)[27].

2.5.1 ORIGIN

The origin of the Human Immunodeficiency Virus (HIV) has been a topic of extreme importance to the scientist since it was identified in the 1980s. It was transmitted to humans from chimpanzees. In 1999, scientists discovered a strain of the Simian immunodeficiency virus (SIVcpz) in a chimpanzee that was virtually identical to HIV. A probable theory about the evolution of SIV in chimps is that they could have consumed the smaller species of monkeys. This virus was transferred to humans either due to consumption of the chimps or due to their blood seeping into the human body via abrasion or cuts while hunting[28].Typically, the human body would defend itself against the SIV contamination, but occasionally the virus would acclimatize itself within its new human host and transform into HIV. In human beings, HIV can be essentially transmitted through 3 ways: -

- By unprotected sexual intercourse
- From mother to child during pregnancy
- Blood borne transmission (usually via needle sharing and

unsterilized injections)

2.5.2 IMPACT AND DEATH TOLL

In 2008, approximately 770,000people died from HIV globally. This figure was 56% less than the deaths in the year 2004 (the peak) and 33% less than the deaths observed in 2010, in spite of the significant upsurge in world population[29].HIV/AIDS deteriorates the economic conditions of both individuals (An individual suffering from this disease is obliged to invest a lot of capital into the treatment which eventually becomes heavy on the pocket.) and the nations. The GDP of several countries have suffered significantly due to the lack of working population as AIDS infected people are often too weak to work. In addition to this, the stigma and stereotypes regarding the disease often lead to discrimination against the afflicted people in both society and workspace. Quite a few people have even lost their jobs. Ryan White (the poster child for HIV/AIDS campaign) was expelled from his school because he was infected[30]. The AIDS stigma is often conjoint with stigmas predominantly related with homosexuality. The Misconceptions and negative attitude often are the reasons behind people feeling discouraged and less inclined towards seeking medical assistance.

2.5.3 COPING STRATEGIES

Even though, currently there is no cure or any kind of vaccine for HIV-AIDS it is still possible for an infected person to live a normal life with the help of proper treatment. The treatment primarily comprises highly active antiretroviral therapy (HAART), which decelerates the advancement of the disease[31]. In supplement to this, the treatment also includes inculcating preventive care against opportunistic infections and a proper diet with plentiful nutrients.

2.6 CHOLERA

Cholera is an illness caused by infection of the small intestine by the bacterium, *Vibrio cholerae*. It sometimes induces severe diarrhea and dehydration, which could result in death.

2.6.1 ORIGIN

There have been seven cholera pandemics globally (Table 1), the initial one originated in India(1817). The causative bacterium is transmitted into the human body via contaminated food (especially seafood) and water, which are a direct result of unsanitary conditions. This table contains the years and origins of the various cholera pandemics. The causative microbe was discovered by FilippoPacini in 1854[32]. His discovery was not extensively recognized until Robert Koch, 30 years later, publicized it as a mechanism to fight cholera[33].

Table 1: Years and origins of the various cholera pandemics.

YEAR OF THE OUTBREAKS	CAUSATIVE PATHOGEN	ORIGIN
1817-1823 (First)	UNKNOWN	INDIA
1829-1851 (Second)	UNKNOWN	INDIA
1852-1859 (Third)	UNKNOWN	INDIA
1863-1879 (Fourth)	UNKNOWN	INDIA
1881-1896 (Fifth)	VIBRIO CHOLERAE	INDIA
1899-1923 (Sixth)	VIBRIO CHOLERAE	INDIA
1961-PRESENT (Seventh)	VIBRIO CHOLERAE	SULAWESI, INDONESIA

2.6.2 IMPACT AND DEATH TOLL

Overly populated neighborhoods with inadequate sanitary conditions are usually more susceptible to a cholera outbreak. According to WHO, there are nearly 1.3 to 4 million cases of cholera per year[34]. Fig.2. Depicts the number of cases and mortality rates from 1950 to 1998 demarcated by continents (Asia, Africa, and The Americas). Due to its brief incubation period, the rise in its cases can be exponential[35].The cholera pandemic also had a very adverse effect on the economic conditions of the affected nations. For instance, due to the cholera flare-up in Peru(1991) the country suffered a loss of US $770 million[36]. This was a direct repercussion of the food trade embargoes and the decline in tourism.

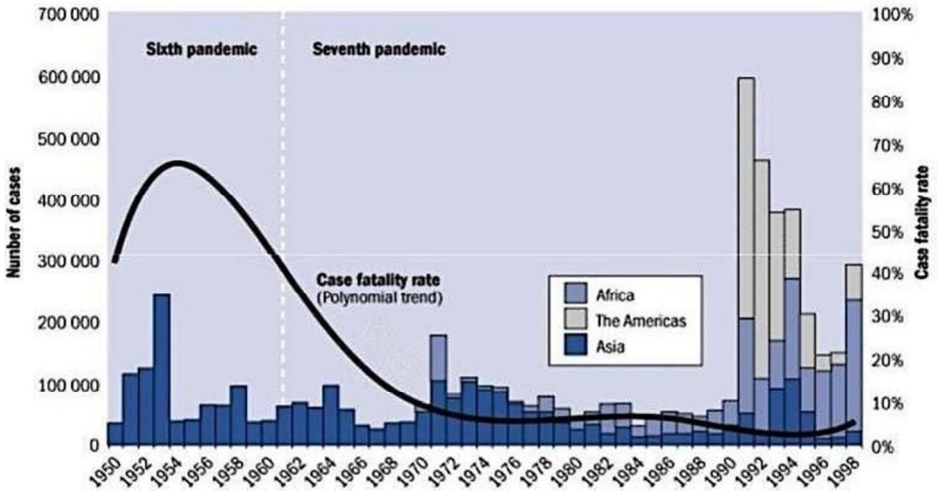


Fig 2. Reported number of cholera cases and case fatality rates (1950-1998)[34].

2.6.3 COPING STRATEGIES

The treatment prescribed is quite elementary as it basically involves rehydration[37]. The WHO endorses the use of cholera vaccines for people located near or travelling to potential outbreak hotspots in supplement with practices like:

- Consuming clean and hygienic water
- Consuming food only with clean hands
- Maintaining hygienic surroundings
- Proper disposal of garbage
- Periodic washing of hands
- Usage of toilets and no open defecation.

2.7 COVID-19(2019-ONGOING)

2.7.1 ORIGIN

The coronavirus pandemic has created an absolute state of trepidation and chaos worldwide. It is caused by SARS-CoV-2 virus (Severe acute respiratory syndrome coronavirus 2). With over 23,752,965 confirmed cases as of 26thAugust 2020[38], it is branded as a highly contagious disease. Initially originating in Wuhan, China (December 2019) the corona virus has now burgeoned across 180 countries. On 11th March Covid-19 was deemed as a pandemic by WHO and has caused approximately 815,038 deaths worldwide[39] and is still spreading at an alarming rate.

2.7.2 GLOBAL IMPACT OF CORONAVIRUS

While the scientists as well as the Research & Development sector endeavors towards discovering a potential vaccine, the government bodies are striving to alleviate the socio-economic conditions within their respective nations. The coronavirus pandemic has instigated the most prevalent global recession since the Great Depression, as per the International Monetary Fund (IMF) all of the G7(Canada, France, Germany, Italy, Japan, the United Kingdom and the United States)[40] nations have been affected or are the verge of being affected by recession. This recession has caused a precipitous escalation of unemployment in various countries. Also, a supply side shortage is anticipated as people are hoarding and stockpiling products in insanely large quantities (panic buying) which have not only led to paucity of the commodities but also to extortionate pricing. Furthermore, the global stock market crashed approximately by 30% during late February-March. Due to lockdowns being imposed worldwide, the tourism sector along with the hospitality sector has undergone a precipitous collapse. In adjunct to this, the coronavirus pandemic has also given rise to severe Xenophobia (Sino phobia to be more precise) and racism against any person who has a South Asian (Chinese) lineage or appearance[41]. The lockdowns and travel ban due to the pandemic has been noted to have a positive effect on the environment. The air pollution has reduced significantly. The waterways and canals have cleared as well. In India, the pollution levels of the holy river Ganga have been reduced by 25-30%.

2.7.3 COPING STRATEGIES

As scientist and researchers are striving to find the potential vaccine these are some practices which, when adhered to can aid in curbing further transmission:

- Circumvent public gatherings.
- Wash hands routinely and properly, for at least 20 seconds. Use a hand sanitizer which has alcohol content of at least 60%[42]
- Avoid close proximity with people who are infected.
- Wear mask while leaving your house.
- Avoid touching your eyes, nose and mouth with unsterilized hands.
- Clean commonly touched surfaces with disinfectants.

3. CONCLUSION

Human society has been plagued with diseases since the dawn of time. From the Plague of Justinian to Coronavirus, pandemics on every occasion have afflicted severe damage to all life forms. In addition to the Brobdingnagian mortality rate, these plagues also have a momentous detrimental impact on the socio-economic dynamic of the affected nations. Bill Gates in his 2015 Ted talks accurately said "Today the greatest risk of a global catastrophe is a highly infectious virus outbreak and not a nuclear war. Not missiles, but microbes and the reason behind this, is the huge capital investment made in nuclear warfare and little in a system to stop an epidemic". That being said, not only the current medical science and the R&D sector, but also the governments of various nations are severely unequipped and underprepared to tackle a widespread pandemic as there is no proper structure in place to deal with such kinds of adversities. The on-going coronavirus pandemic is the most exemplary example of this, the governments of almost every nation were taken by surprise and their tardiness in taking appropriate steps have resulted in further deterioration of an already dire situation.

4. FUTURE PROSPECTS

The conventional "business as usual" approach won't suffice this time. Nathan Wolfe, the author of "The Viral Storm: The Dawn of a New Pandemic Age," in his article for TIME said, "COVID-19 will not be the last pandemic in our deeply interconnected world, and sadly it won't be the worst." To protect ourselves from the menacing prospect of future pandemics, first and foremost wild animal trade must be prohibited. Animals (especially mammals) contain approximately 750,000 highly infectious viruses, if we could curb the contact between the human world and the wildlife the possibilities of a future pandemic will decrease significantly. Secondly, copious amounts of funds should be dedicated towards research work and should be released expeditiously in case of an outbreak. In addition to this, proper legislation should be in place to deal with upcoming pandemics. Having a wide-ranging spectrum of measures, preventive care and proper structure of protocols to deal with a virus outbreak is extremely critical at this point as the adversary is capable of constant modification. And lastly, there needs to be a balance between the desideratum of development and protection of nature. Our development schemes should not only be sustainable but also eco-friendly. The causative pathogens are the genesis of every pandemic, that has occurred throughout history, and are constantly evolving and mutating. Thus, our coping strategies need to be adaptive and innovative in order to overcome the adversary.

5. AUTHORS CONTRIBUTION STATEMENT

Adya Trisal and Bhoomika Pandey conceived, conceptualized

and presented the manuscript as well as all the essential methodologies including the literature survey and data collection. Dr. Dheeraj Mandloi and Tapesh Sarsodia supervised the process, helped in analysis of the data and gave necessary inputs and guidance in writing this manuscript. Sapna Jain Dabade gave inputs pertaining to the overall presentation of paper. All authors discussed the presentation, results and contributed towards the final manuscript.

7. CONFLICT OF INTEREST

Conflict of interest declared none.

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