

**VACCINE: A SOLUTION OR A CHALLENGE? A PUBLIC OPINION ABOUT VACCINE IN 2020****Rahul*¹, Naman Wadhwa²**¹Centre for Bioinformatics, Maharshi Dayanand University, Rohtak, Haryana, India²Department of Biotechnology, University Institute of Engineering & Technology, Kurukshetra University, Kurukshetra, Haryana, India*Corresponding author: ratheerahul089@gmail.com**ABSTRACT**

Across the world, millions of people get infected and contract diseases, which can be avoided with age-appropriate health measures. Vaccines have always been a significant part of the healthcare system, which aided humans to thrive despite critical outbreaks in the past. Vaccines have remarkably reduced the mortality rates and have thus increased the overall health of citizens. During COVID-19, the word “vaccine” has gained significant popularity and the world is waiting for a vaccine as a preventive measure for COVID-19. Since the development of the first vaccine, there have always been certain social, financial, and religious aspects related to the vaccination. As per previous studies, literacy, gender, lifestyle, and financial factors influenced the vaccination among certain groups, communities, and regions around the world as vaccines have not always been viewed positively. A survey entitled as, “Are you aware of vaccines?” was conducted to analyze the public opinion regarding vaccination, and promising results were obtained. As per the survey, most of the survey takers emphasized that the government must hold accountability for the vaccination. Amidst the Covid-19 pandemic, 27 % people are even ready to be the part of clinical trials despite knowing the possible adversities. The foundation of the world is built by its healthy population; this must be fueled by implementing appropriate healthcare guidelines by concerned authorities. For a better tomorrow, the campaigns need to be conducted to educate masses regarding vaccines, their efficacy, and influences, which will prepare us for any unforeseen pandemics or outbreaks in the future.

Keywords: Vaccine, Immunization, Covid-19, Pandemic**1. INTRODUCTION**

Diseases have co-existed with humans and they are mainly caused by microbes that rely on human bodies for completing some part of their life-cycle. The sole reason behind the human population crossing the 7 billion mark is advancement in healthcare systems and vaccines have been an integral part of it. Vaccines have saved countless lives worldwide because vaccines work on the principle of simulating the mild real-time infection and eventually prepare the immune system against the actual disease. Vaccines are made up of weak, inactivated microbes, or surface proteins, and could be a modified microbial toxin. The term vaccination refers to receiving a vaccine, which can be administered through oral, edible, or intravenous routes whereas immunization refers to the process of getting immune (resistant) to a specific disease. The objective of vaccination is to expose the body to the weakened microbe or a part of it so that the body can generate an immune response for the disease without catching the actual disease and shall be fully

prepared on exposure to the actual disease-causing microorganism.

Vaccines not only protect the ones who are vaccinated but also those who were unable to get vaccinated by providing immunity to the vaccinated ones and thus, preventing them from becoming the carriers of the disease. It also reduces the dependence on drugs for treatment because vaccinated people generally don't get infected and thus, helps in the prevention of Multi-Drug Resistant Strain development of microorganisms. Children and the elderly have more chances of getting infected with the diseases because of the weakened immune system and vaccines primarily aim to save people of both these age groups. Moreover, vaccines end up saving people from getting infected from life-crippling diseases like Polio. Diseases like Small Pox have been eradicated because of vaccination; however, Pertussis (whooping cough), which is a highly contagious condition, displayed a comeback in Japan, Sweden, and Great Britain where its vaccination was discontinued

because of the fear of vaccines. In Great Britain itself, vaccination was reduced in 1974 and there were 100,000 cases until 1978 with 36 deaths (WHO data). As per the reports, UK was declared as Measles free in 2016 but, in 2019 UK reported the cases again and the elimination status was lost as the vaccination rate was below 95%,

which is needed to maintain protection against infectious diseases like Measles. In 2019, there was a 300% spike in the number of cases reported for Measles annually as compared to 2018 [1]. The Table 1 displays the data related to various diseases:

Table1: Different diseases that have caused severe mortality

<i>Outbreak</i>	<i>Pathogen/Causative Organism</i>	<i>Year of outbreak/ Infection reported</i>	<i>Number of Deaths/Infected People</i>	<i>Current Treatment</i>
Small Pox	Variola Virus	1500 BC-1980	300 million(1900-1980)	Vaccine(ACAM2000 and APSV)
Polio	Poliovirus	1580 BC- Present	7516 (1951-1954) in US	Oral Vaccine
The Black Death	<i>Yersinia pestis</i> (Bacteria)	1347-1351	250,000,000	Antibiotics
Pertussis	<i>Bordetella pertussis</i>	1578-Present	160,700 (2014)	Vaccines, Antibiotics
Diphtheria	<i>Corynebacteriumdiphtheriae</i>	1613-Present	7,097 (Reported globally as in 2016)	Toxoid as DTP, DT or Td
Yellow Fever	Flavivirus	1648-Present	29,000-60,000 (2013)	Vaccination
Measles	Rubeolavirus	1657-Present	142,000 (2018)	Routine Vaccination
Cholera	<i>Vibrio cholera</i>	1817-Present	120,000 Yearly	ORS
Typhoid	<i>Clostridium tetani</i>	1884-Present	314,000 (1990) 38,000 (2017)	DTap (Infants) Tdap (Adults)
Spanish Flu	H1N1 (Spanish Flu Virus)	1918	50-100 million	Tamiflu and Relenza
Asian Flu	H2N2 (Asian Flu Virus)	1957	1.5-2 Million	Antipyretic Drugs
HIV/AIDS	Human Immunodeficiency Virus	1959-present	770,000 (2018)	Antiretroviral treatment
Hong Kong Flu	H3N2 (Hong Kong Flu Virus)	1968	1 Million	Improved Healthcare Systems and Antibiotics
Swine Flu	H1N1 (Swine Flu Virus)	2009	151,700-575,400	Tamiflu and Relenza
Covid-19	SARS-CoV-2	2019-Present	566,355 (Till 13/07/2020)	None

Flu which is caused by Influenza virus has been a major threat to humans because of the significant mortality caused during major outbreaks in the previous century and last decade. One of the most typical features of Influenza virus is antigenic variability [2] which refers to a change in surface proteins because of which it becomes difficult to make a vaccine against it. The disease is highly contagious and affects the respiratory system of humans.

The Influenza viruses are classified based on the surface proteins, which are Hemagglutinin (H) and Neuraminidase (N). The Hemagglutinin has 18 subtypes (H1 to H18) and Neuraminidase has 11 sub-types (N1 to N11), (Table1). Contrary to COVID-19 in which, the mortality in senior citizens is higher, in the case of Influenza Viruses there has been a shift in mortality towards younger people <60 years [3].

2. HISTORY OF VACCINATION

The history of vaccination (Figure 1) dates far back to 1000 AD in China where variolation (inoculation) was done to immunize individuals [4].

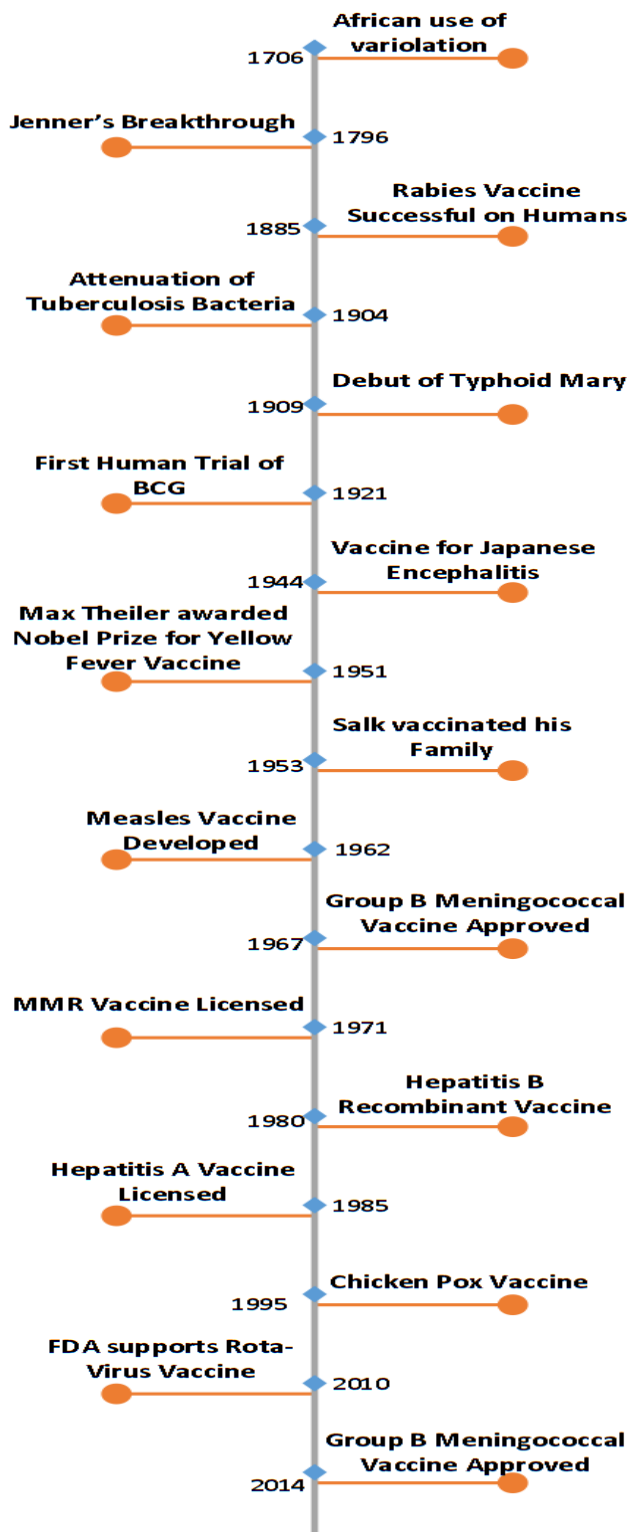


Fig. 1: Timeline for major events in the history of vaccines

Smallpox caused by *Variola Virus* had been a cause of countless fatality until the last century and it was eradicated worldwide on 8th May 1980 as per the Centre for Disease Control and Prevention (CDC). It had existed since long back and the Mummies from Egypt, which dated back to 1500 BC, had lesions similar to those observed in Smallpox patients. Being highly contagious and infectious, it resulted in millions of deaths each year in Europe until the 1900's. Dr. Edward Jenner observed that dairymaid women who were once infected with Cowpox (milder than Smallpox) didn't get Smallpox. The doctor took a part of the lesion of a Cowpox patient and inoculated a young boy who developed mild symptoms for a few days but recovered soon. Afterwards, the boy was infected with lesions of a Smallpox patient and he showed no symptoms and was hence considered immune to the disease. The antibodies developed due to Cowpox infection helped in fighting with Smallpox infection. Hence, Edward Jenner is referred to as the Father of Vaccinology [5] for his contribution. One of the most interesting stories is of Mary Mallon who was nicknamed as "Typhoid Mary". She used to work as a domestic helper in the US in the early 1900's was a healthy carrier of bacterium *Salmonella typhi* and she infected a group of families, where she used to work. It was long before discovered that the disease spread due to contaminated food and water because of the spread of rod-shaped bacteria (bacillus) [6].

3. SOCIAL IMPACT OF VACCINES

Whenever a new outbreak is reported, health organizations including CDC and WHO needs to set guidelines to contain and control the spread of the disease throughout the world. Along with guidelines, appropriate treatments need to be implemented as per the situation. Currently, the world is going through the Covid-19 pandemic, which has already impacted millions of people across the globe, and until now, health organizations have no significant alternative to tackle this situation. Investment in a vaccine is a critical matter as it works for one and all i.e. when one vaccine is developed and launched for a cause, it works for one disease, but, it works for the entire society. The vaccine manufacturing industries play a vital role in keeping the world disease free because vaccines are procured by WHO, UNICEF and other major organizations also. The DCVMN (Developing Countries Vaccine Manufacturers Network), which is an alliance of global vaccine manufacturers works on the common goal of providing quality vaccines to the society [7]. The development of a

vaccine is a cost-effective business, which if implemented as a preventive measure can benefit each individual and society as a whole and financially rewarding to the vaccine producer because vaccines are used universally [8]. As per the survey conducted, 66.8% people are expecting to have a vaccine as a preventive measure for Covid-19.

Poor countries tend to invest less for healthcare and vaccination, thus it raises concerns regarding health measures, which demands strategic improvements in public health systems and services to overcome healthcare barriers. Lack of investment in healthcare also impedes research and development by biopharmaceutical companies, which ultimately affects the vaccine development for a specific disease that spreads locally. The deprived planning and global management along with lack of investment results in gaps in healthcare facilities, which needs to be addressed on a serious note.

Countries like India with the burgeoning population, where many people can't afford the cost of vaccination; government run vaccination programs are regularly needed. Due to high cost and low affordability, the vaccination coverage is below the global average, which results in the need for extensive nationwide programs for improving the healthcare facilities nationwide. To increase immunization coverage in our nation and for renewing the old Universal Immunization Program (UIP), Mission Indradhanush was launched in some selected districts of India [9]. Under this program,

vaccination for eight vaccine-preventable diseases (VPD) is being provided against Rotavirus, Japanese Encephalitis, Haemophilus Influenza Type B, Tuberculosis, Diphtheria, Tetanus, Whooping Cough, Poliomyelitis, Measles, and Meningitis. It not only covers the children but also pregnant women [10]. India, which was once considered as the toughest place to eradicate Poliomyelitis because of its dense population and poor sanitation was declared Polio free in 2014. It was done by routine immunization and active monitoring of areas with Paralytic Polio cases and promotion by the Government [11]. The tagline of Polio Elimination Initiative was, "Doo Boond Zindagi ki", which translates to, "Two drops of life". It was highly popular amongst Indian people.

4. COVID-19 AND THE WORLD IN 2020

The Covid-19 (Corona Virus Disease -2019) is caused by the SARS-CoV-2 virus with patients having fever, dry cough, and tiredness, etc.; however, some may remain asymptomatic too. The initial cases were reported in Wuhan, which is the capital of the Hubei Province of China and gradually spread throughout the world (Fig. 2). Previously it was estimated that it came from bat associated coronavirus because there was a difference of only 4% in the genomic nucleotide sequence of bat-related coronavirus (RaTG13) and SARS-CoV-2, but the difference at neural sites was 17% and thus the theory doesn't seem satisfactory [12].

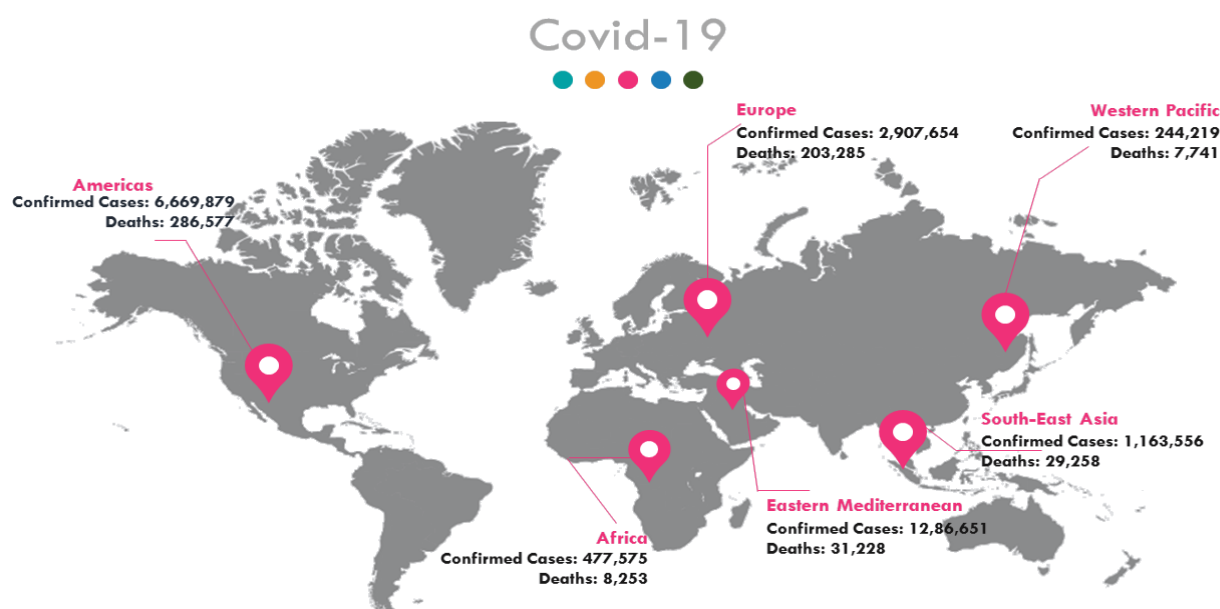


Fig 2: Total infected and total deaths due Covid-19 globally as on 13th July, 2020.

The virus has impacted humans physically, mentally, and economically due to the worldwide lockdowns and restrictions, which have been imposed in many countries to avoid public gathering to ensure their safety. The hand-to-mouth earners have been the worst affected throughout the world. This outbreak was declared a pandemic by the World Health Organization (WHO) and has caused enormous deaths throughout the world (Table 2). The world's economy is badly hit because many financial activities are halted due to restrictions and the people are not accustomed to newer ways of prevention including Social Distancing and Sanitization.

Table 2: World Health Organization data about death during Covid-19 pandemic across the globe (13th July, 2020) [13]

Region	Confirmed Cases	Number of Deaths
Americas	6,669,879	286,577
Europe	2,907,654	203,285
Eastern Mediterranean	1,286,651	31,228
South-East Asia	1,163,556	29,258
Africa	477,575	8,253
Western Pacific	244,219	7,741

In absence of any drug or a vaccine for Covid-19, certain other approaches are being practiced to treat patients such as Plasma therapy [14], in which the plasma of recovered patients from Covid-19 was taken as it contained antibodies against the virus. So far, it has proven to be quite a satisfactory alternative for recovering from Covid-19; however, obtaining plasma from patients can be a challenging task. In India, Ayurveda is being popularized by Ayush Ministry to treat Covid-19 and primarily as an immunity booster. Tracking of Covid-19 suspected patients and surveillance of people for treating Covid-19 is being done through certain software applications known as the "AarogyaSetu" App.

5. SURVEY DETAILS

5.1. Methodology

An Online Survey entitled as, "Are you aware of Vaccines?" was conducted via Google Form, an open-source facility by Google, where 220 responses were obtained between 7th to 10th July 2020, and all the results were kept fully confidential. The survey was circulated through social media platforms using WhatsApp, Instagram, and Facebook, primarily within

the state of Haryana. In the conducted survey, 13 questions were asked in Multiple Choice Format.

The main objective was to analyze the opinion of the public regarding vaccines and to make them aware of certain basic information regarding vaccines because the word "vaccine" is highly popular amidst Covid-19.

5.2. Sample

A set of 220 responses were obtained, 53% of them were females and rest being males. The average age of respondents was 24.97 years.

5.3. Outcomes

The results of the survey were quite promising and it was visible that the word "vaccine" is well understood by the people. Vaccines play an integral role in generating immunity during childhood against deadly diseases and 66.5% of people agreed that they won't have been able to survive all the possible infections without vaccines. Surprisingly, more than 3/4th of survey takers knew that micro-organisms are involved in vaccine production and 97% of the respondents agreed that vaccines are responsible for saving millions of lives worldwide and 83% said that vaccination must be mandatory for all. In absence of booster-doses, an infection can occur and 60% of people agreed that booster doses are important, but the rest 40% who didn't know properly raised a concern that along with vaccines, knowledge of booster doses is also important. While the world is impatiently waiting for a Covid-19 vaccine while 67% of people already knew that it generally takes years to produce a vaccine. As per the survey, everyone was ready to get vaccinated, but only 36% of the survey takers agreed to be a part of human clinical trials. About 67% of participants considered that a vaccine is the only solution to Covid-19; potential drug availability was the second choice among the participants. Vaccines are generally sponsored by government; however, 55% people agreed that vaccination should be subsidized i.e. it must be available at affordable prices while 38% of them said that government shall fully bear the cost and rest of participants pointed out that the cost of vaccination must be endured by the individual. In case of any side effect caused by vaccination, 40% of people said that the compensation must be borne by the vaccine producing company while 33% commented that the government should bear it, and the rest of them viewed it as a personal matter. The opinion about herd immunity was also analyzed and results were almost neutral with half of

the people preferring herd immunity as an option to deal with Covid-19 and the rest preferring the vaccine as a solution to Covid-19.

6. SOCIO-ECONOMIC ASPECTS OF VACCINATION

Economy of the nation is determined and derived by its population and a healthy community leads to a healthier world, which promises better prospects for economic advancement all around the world. A healthy individual contributes to society and derives the growth of the economy by being self-supporting and productive for longer. In a particular study, it was found that the return on investment on the cost of vaccine was found to be 16 times the cost of illness born at hospital and 44 times the value referred by people in living longer lives [15]. The Vaccination promises a disease-free life and helps in reducing the chances of being infected allowing more and more population to be active and prolific.

The high cost of vaccines and poverty among developing countries makes it difficult to implement vaccine-preventable diseases (VPD) campaigns for children, which ultimately results in hindered growth and development among the upcoming young generations. A part of the study conducted on the NDHS (Nigeria Demographic and Health Survey) dataset from 2013 suggested certain socio-economic barriers that obstruct the vaccination among children [16]. The data analysis concluded that parental literacy and household income influence the continuation of vaccination among children, i.e. high literacy, balanced lifestyle, and high income of the family significantly associated with continued vaccination and vice versa.

Global investment plays a critical role in achieving worldwide disease-free population. For instance, it is difficult for poor countries to supplement and support the vaccination due to its higher costs. Global investment assists poor countries by making vaccines more affordable at low-cost prices as these countries are dependent on external financial assistance.

Currently, traveling across the world has become an integral part of businesses and air travel made it easier like never before. The entire tourism industry is powered by people traveling all over the world for work and leisure. Each country follows a guideline for its travelers to have a full record of vaccination before traveling to prevent the spread of any infectious disease. A proper vaccination reduces the risks of being infected and thus,

makes it safer for people to travel without any health-related scrapes.

7. CONCLUSION

The recent outbreak of Covid-19 is teaching mankind the ways to live with diseases and how to be future-ready to tackle such situations if needed. The entire world is severely affected and everyone is expecting a vaccine as a panacea to Covid-19. More surpassing collaboration among research groups can facilitate the vaccine development process as a result of more collaborative manpower and resources. Furthermore, open-source projects for vaccine development in this crucial time are imperative for reducing the cost and efforts along with the effective utilization of resources. A vaccine is not the requirement of the one country but the whole world and this raises the utmost concern recently when the Covid-19 outbreak halted the world. Vaccine development is a cost-effective process and global investment must be practiced by healthcare regulatory organizations to supplement the need of the poor developing countries during such outbreaks. The developing countries like India, which have partly controlled the spread of the disease by implementing social distancing and nationwide lockdown; however, this pandemic made us understand the potential loopholes in our healthcare system. Conventionally, it takes 10-12 years for a vaccine to come in the market; however, with the advancement in bioinformatics, the vaccines have reached human trials within a few months after the outbreak. Implementation of artificial intelligence and machine learning assisted in the identification of potential drugs and vaccines, which are being directed for further studies and might come out for human usage in the coming months or a year. Global investment should be considered in the field of research to produce drugs and vaccines to make them affordable for everyone. All people must have a right to better treatment and significant gaps in the healthcare system should be managed carefully to provide health care services to everyone. To fight with such outbreaks and diseases in the future, we need to be prepared because each time social distancing and lockdown would not be a feasible option and maybe we won't even have enough time during the next pandemic.

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