Herd Immunity: An End to the Global Covid-19 Pandemic Crises

Shouvik Bhadra, Sweta Das, Sampa Biswas, Rajat Pal*

Department of Microbiology and Biotechnology, Sister Nivedita University, Kolkata, West Bengal, India.

ABSTRACT

A good deal of scientific and clinical information has been collected in the wake of Coronavirus disease (COVID-19). The virulence, infectious nature, and molecular diagnosis of the virus need to be studied more in order to obtain more information because the SARS-CoV-2 is undergoing a genetically normal evolution, which is a dynamic process. The immune system engages in the fight against viral infection through pathogen elimination, cellular homeostasis, tissue repair, and memory cell generation. Which are reactivated upon exposure to the same virus and preparing the body for future encounters with the virus through vaccination. As a result of vaccination or developing immunity from prior infection, a population obtains indirect protection against infectious disease. When this immune response occurs in 80% of a population, it is known as "herd immunity". SARS-CoV-2 has spread rapidly across communities. If it is to be stopped, a significant percentage of the population must be immune.

Keywords: Accessory Proteins, Effective Reproduction Number, Herd Immunity, Microbiome, Transmembrane Protease Serine, Viral Epitopes.

Address for Corresponding Author

Dr. Rajat Pal; Department of Microbiology and Biotechnology, Sister Nivedita University, Kolkata, West Bengal, India.

E-mail: rajat.p@snuniv.ac.in

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Introduction

The SARS- CoV-2 infections in humans were first identified in China (Wuhan, Hubei Province) on 8 December 2019. The outbreak outside China occurred in early 2020, and Italy was the first country in Europe and worldwide to be severely affected by the virus in early March following on February 21, 2016, the index case was detected at the Codogno Hospital in the region of Lombardy. COVID-19, a global public health emergency, was declared a pandemic by the World Health Organization on 11 March 2020. (WHO database, 2020) SARS-CoV-2 has been responsible for 70 461 926 infections and 1 599 704 deaths. COVID-19 has shown remarkable variability between countries and continents in terms of incidence, mortality, and lethality, some of these factors may be unknown but others may be known such as advancing age and gender, and comorbid conditions such as chronic diseases. Age and comorbidity are independently associated with increased susceptibility to the infection and its clinical effects. Vaccines have historically led to a substantial drop in disease cases and even their eradication, and herd immunity is achieved against infectious diseases like smallpox, polio, measles, rubella, diphtheria, pertussis, and mumps.[34] Innate immunity is inherited and is present in one's body since birth. An immune reaction against an antigen gets activated at birth and persists throughout life. Acquired immunity is established at the level of the individual, in response to natural infection or the immunization of the individual. As a result of exposure to a foreign substance, an immune response is developed.

Herd immunity refers to the indirect protection from infection afforded by immune individuals in a given population, which helps limit the spreading of diseases.[43] Following a successful recovery from a disease, vaccination is an option as well as a natural treatment.[23] Several factors influence herd immunity, including the proportion of the immune population, the duration and effectiveness of the immune response, and the stability of viral epitopes.[44] Significant concern exists about the development of herd immunity against severe acute respiratory syndrome coronavirus (SARS-CoV-2) due to these factors.

The History of Herd Immunity

Herd immunity has been successful in preventing or even eliminating infectious diseases many times in human history.[10] In general, smallpox is considered to be one of the most dangerous infectious diseases humans are susceptible to. Human populations have been exposed to it for thousands of years in ancient times as well as more recently.[13] Smallpox was officially eradicated in 1979, based on the success of intensive vaccination campaigns.[12] As a result of the introduction of vaccines in 1988, the United States fell to 1.3 cases per million. Two measles elimination programs were carried out, and the re-emergence of indigenous transmissions in the United States has been eradicated since 2000.[11-14] Following the widespread introduction of whole-cell pertussis vaccines into childhood immunization programs in the mid-1940s, the incidence of pertussis dropped significantly, from 150,000 - 260,000 cases to just 1010 cases every year by 1976.[14]

Taxonomy of Covid-19 Virus

Currently, coronaviruses are classified into 39 species, 27 subgenera, five genera, two subfamily members within the Coronaviridae family, subdivision Cornidovirineae within the order Nidovirales, and realm Riboviria.[1] Family classification and taxonomy are developed by the Coronaviaridae Study Group (CSG), a working group of the ICTV[2], there is a long journey of transmission from birds to mammals, but yet it has not been found in reptiles and amphibians. Human-COV viruses are classified into one of two genera: Beta coronavirus and Alpha coronavirus; both Alpha and Beta viruses are part of Coronavirinae (subfamily) below Coronaviridae (Figure 1). Human MERS-COV, SARS-COV, and most recently Pandemic SARS-COV-2 (COVID-19) belong to the Beta Coronavirus genus.[33] Their genomic sequences are almost 83.9% similar.[7]

There are various Beta and Alpha coronaviruses found in mammals, such as Hedgehog COVs, Rat COVs, Murine COVs, Antelope COVs, Human COV HKU1, Human COV OC43, Human MERS-COV, Human-SARS-COV-1, Human-SARS-COV-2 members of the Beta-Corona genus, and Human -COV-229E, Human-COV-NL63, Dog COVS, pig-COVs, Sorex-COV all belong to the Alpha Coronavirus family. These viruses can be found in birds and are known as the Bulbul-COV, Munia-COV, Night Heron-COV, and Wigeon-COV, A member of the Delta Coronavirus family. There are a couple of viruses found in whales including Beluga whale COVs and Bottlenose dolphin COVs, which are related to Gamma coronaviruses.[3]

Morphology & Genetics of Sars-Cov-2

Covid-19 causing human coronavirus (SARS-COV-2) have the largest mature viral genome with (27-32 kb) with 80-120 nm diameter.[4] SARS-COV-2 contains single-stranded positive-sense RNA like MERS-COV and SERS-COV connected with nucleoprotein covered by a capsid protein (see figure 2).[6] The viral ORFs are produced through purifying selection. Some of the most restricted sequences were found in non-structural proteins (NSPs) and membrane proteins.[5] Generally, all positive sense ss RNA virus has icosahedral symmetrical structured capsid but in case of SARS-COV-2, contains a helical structured capsid. Non-structural proteins (NSPs), accessory proteins, structural proteins including spike(s), envelope (E), membrane (M), and nucleocapsid (N) proteins all are translated from the viral genome of SAR-COV-2 viruses. The s protein helps the virus to attach with the host cell, then the virus can enter; the N protein supports the nucleocapsid formation, assisting the virus budding, RNA replication, and mRNA replications; together the S, E, and M proteins constitute the viral envelope.[37]

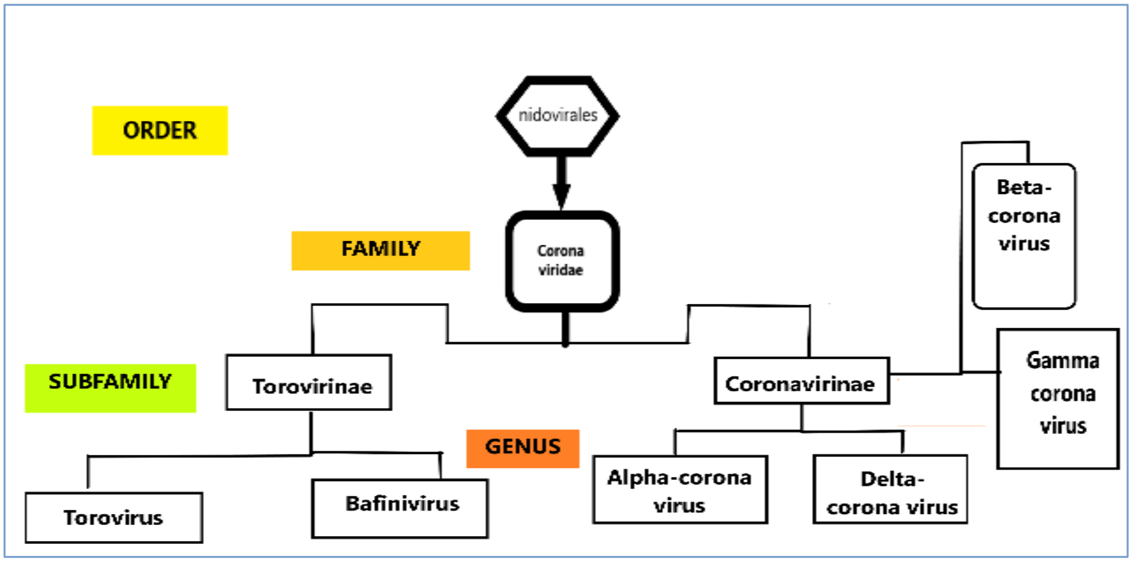

Figure 1: Order of Classification from which coronaviruses belong to, its family (Viridae), subfamily (Virinae).[33]

The s-protein consists of an N-terminal s1 subunit and a C-terminal s2 subunit (**Figure 2**). In addition, a Furin fragmenting site at the junction of s1 and s2 subunits in the spike protein of SARS-COV-2 was found which isn't present in any other SAR-COVs. Genetical data analysis suggests that SARS-COV-2 is different from other SARS-like COVs viruses by 12.8% and 83.9% similar in minimal RBD.[7]

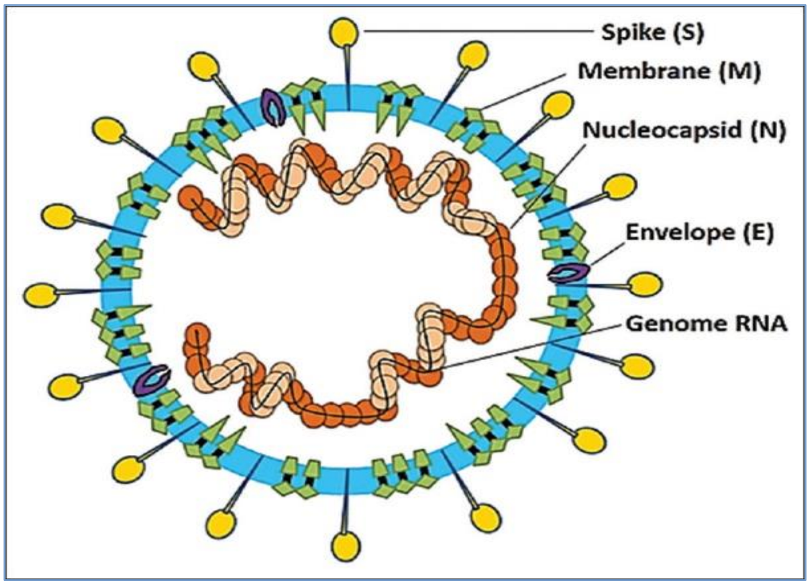

Figure 2: A symmetric structure of SARS-COV-2, SARS-COV, MERS-COV.[6]

The s protein of the virus connects with the Angiotensin-converting enzyme 2(ACE2) receptor on the host cell surface with the help of the type 2 Transmembrane Protease Serine (TMPSS2).[8] It cleaves the s protein into two subunits s1 and s2 during the viral entry of host cells.[8] Recent studies have defined that there are other cell receptor presents in different cells involved in viral entries into the host cells. In the case of SARS-COV, CD-147 is found to be a receptor of epithelial cells as well as SARS-COV-2.[9] Dipeptidyl peptidase 4 (CD4) was also found when the MARS-COV virus was spreading in middle-east, it was also found while studying the SARS-COV-2.

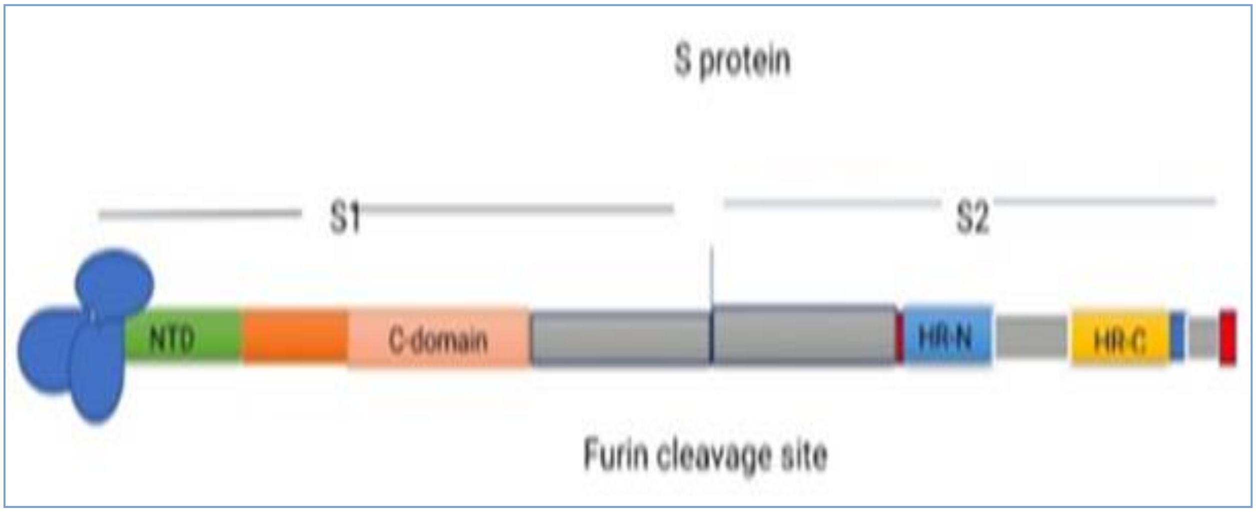

Figure 3: SARS-COV protein structure.[33]

WHO reports that SARS-CoV-2 has killed more than 3,877,316 people and infected more than 178,701,170 individuals globally as of June 23rd, 2021. Consequently, SARS-CoV-2 has a higher transmission rate than SARS-CoV in 2002-2003, which had infected 8,098 and killed nearly 700 people. Genetic recombination occurred in the RBD of the S protein, leading to the development of the transmission ability of SARS-CoV-2.[33]

To prevent the contagious disease associated with SARS-COV-2, it's important to determine the source of origin and transmission of the virus.

Huanan Seafood Market in Wuhan, China, became a source of the outbreak, and over 50 people became infected with SARS-CoV-2. It was typical for this market to regularly sell live animals like parrots, birds, frogs, rabbits, snakes, and bats. Genomic analyses revealed similarities between SARS-CoV-2 and SARS-like bat viruses, hence bats are suspected to be reservoirs for SARS-CoV-2.[35] In another study, the origin of SARS-CoV-2 has been associated with Pangolin-CoV, because Pangolin-CoV was found to be 91.02% and 90.55% identical to SARS-CoV-2 and Bat-CoV, respectively.[36] Close contact with these infected animal reservoirs is the major cause of animal-to-human SARS-CoV-2transmission[38], which eventually leads to rapid human-to-human transmission.[33] Human-to-human transmission is mainly mediated by respiratory droplets and contact transmission.

The spread of aerosols is also suspected to be an important means of transmission.[37]

Human Immune Reaction to Covid-19 Virus

Each day, thousands of liters of air are inhaled, carrying pathogens from the surrounding environment to our lungs. In the lungs, mucus acts as a protective layer to encase pathogens and small particles, and it coats the epithelial tissues, which can be cleared by coughing. This barrier permits Coronaviruses to pass through, which are typically found infecting humans in the lungs.

An innate immune response is the body's first defense against infection, which constructs different pathogen recognition receptors (PRRs). For RNA viruses, the RNA genome, replication, and metabolic products represent major non-self-products harboring PAMPs (Pathogen associated molecular patterns) that are recognized by several PRRs like RIG-I (retinoic acid-inducible gene I), MDA5 (melanoma differentiation-associated gene 5) recognition.[39] After entering into the lung epithelial cells, recognize SARS-COV-2 as a pathogen via pattern recognition receptors (PRRs). Alveolar macrophages secrete inflammatory proteins as the first responder (TLR2, 4, 6, IL-1R, TNFR as well as CD200, SIRP) which regulates the roles in controlling the immune system. In the airways and lungs, a subset of dendritic cells (DCs) uses their dendritic structure to penetrate the epithelium for antigen capture. Antigen was subsequently processed for presentation by MHC 1 and MHC 2 TO CD8+ T and CD4+ T cells.CD4+ T cells assist in the overall adaptive immune response by stimulating B cells and CD8+T cells, mediating both durable antibody-mediated and cellular immune responses and developed memory cell populations. Secretes molecules to recruit immune cells that regulate the adaptive and innate immune response.[40]

An adaptive immune system has two main mechanisms for producing immunity-a) cell-mediated immune response and b) humoral immune response. The humoral immune response is working in the interaction of B-cells with antigen and differentiates with antibody-secreting plasma cells and the effector T-cells interacting with antigens, this is responsible for cell-mediated immune response. Human coronaviruses contain different proteins that play an important role in viral infections. It contained five cytotoxic T lymphocyte (CTL) epitopes, three sequential B cell epitopes, and five discontinuous B cell epitopes. After entering into the host cell T cell receptors recognize the antigen (virus) which is bound to the MHC molecules and form the binding antigen-MHC molecules. The activated TH cell secretes cytokines that help to activation of B cells as well as TC cells. TC cells are developing cytotoxic T lymphocytes (CTLs) and recognize altered virus-infected cells and kill those cells. In the case of Humoral response, the activated B cells interact with the antigens and transform into Antibody secreting plasma cells. The antibodies bind with the antigen and neutralize its clearance from the body.[41]

Managing the transition between innate and adaptive immune response is very important for controlling SARS-COV-2 infection and its dependent on CD4+ T cells to interact with B cells to produce specific neutralizing antibodies. In most infected individuals, antibodies are detectable in the first 1-2 weeks after infection onset. Specifically, IgM and IgA against SARS-COV-2 have been detected after 14 days. Recent studies indicate that the antibody neutralizing capacity depends on the severity of infection and antibody responses faded after some weeks in case of COVID-19 infection. The antibody decreasing rate in asymptomatic individuals is lower than the symptomatic individuals. For SARS-COV, the long-lasting specific IgG, neutralizing antibodies remained almost 2 years.[41] It was possible to detect IgG and neutralize antibodies against MERS-CoV up to 15 months after symptoms began.[42] If the majority of susceptible individuals are being immunized by a sars-cov-2 virus, then neutralizing antibodies will generate in a huge population which may build a way to go for a Herd immunity threshold.

Herd Immunity

The herd is a term used to describe a large group of animals, especially hoofed mammals, living or keeping together. Wilson and Topley first coined the term herd immunity in 1923. which served as the basis for vaccines, applications, and vaccination programs, especially against certain viral infections.[34] A simple explanation of what herd immunity or herd protection means is when most of the population is immune to an infectious disease, this provides indirect protection to rest with no immunity to the disease. In other words, those with restricted immunity, or those susceptible to the infection, can indirectly benefit from the immunity of the majority.

There has been a significant decline in the number of cases in the past and even eradication is rendered by vaccines, and herd immunity is achieved against infectious diseases like Smallpox, Polio, Measles, Rubella, Diphtheria, Pertussis, and Mumps.[34]

As an example, if 80 percent of the population becomes resistant to disease, four of five people having contact with the disease will neither be affected nor spread it, which would reduce or eliminate the disease transmission within a population. The proportion of the population needed to get herd immunity depends on how contagious the infection is, generally, to achieve herd immunity, 70% to 90% of individuals need to be immune. The effect at the level of population is often considered concerning immunization programs. A key objective of herd immunity vaccination programs is the establishment of immunity in the population. The individuals who are left or not vaccinated are still protected against disease as the number of susceptible hosts would be less.

In an effort to control the COVID-19 outbreak, one solution has been proposed: herd immunity.[23] Herd immunity can be generated in a population by two processes, the first one is naturally generated adaptive immunity and the second one is artificially generated immunity. Natural immunity generates when the individual gets infected with the disease or by introducing a weakened or killed strain of the disease organism directly into the body (vaccine-induced immunity). In either case, if an immune person comes into contact with that disease again in the future, their immune system will recognize it and produce antibodies immediately to defend against it. For this reason, Vaccination may be the key of control the infection rate and also the death rate of this infectious disease. The herd immunity threshold will be reached when more than 60% of populations are immune to the contagious disease.

Herd immunity can prevent epidemic transmission as it can downsize the transmission rate in the population. Preventing the infection through this approach remained consistent with Darwin's Survival-of-the-fittest theory.[31]

Herd immunity is affected by the Basic Reproduction rate (BRr), which indicates how many people may be infected by the transmitted cases. It can show how faster the disease will spread in the population. According to the basic reproduction rate (BRr), herd immunity is evolved by following three rules for spreading a pandemic, following concepts of social distancing: susceptible, infected, immune cases rules. The population members are moved from susceptible to infected and from infected toimmune with respect to the herd immunity threshold by adopting Darwin's survival-of-the-fittest principle. There were a few members of the infected group that reached a fatality state as a result of having suppressive immunity or any other critical complications.

Population Hierarchy

The herd immunity population can be classified into three types[38]:

Susceptible individuals are not infected by the virus yet but they can be infected when they interact with the infected individuals if they don't follow the recommended rules.

Infected individuals have a confirmed case of infection where they can transmit the virus to other susceptible individuals who are in direct contact with the infected individuals.

Immunized individuals are protected from the virus by having a natural infection or getting vaccinated and also give protection to the susceptible individuals**.** This type of individual can help the population to stop spreading the pandemic as shown in **figure 5.**

When the disease started spreading into pandemic proportions, the susceptible individuals take a large portion of the population. A second population segment is marked as a subset of those who are infected, which are initiated with a very small number which represents as first infected individuals appear in population and this portion of the population grows up if there is no maintenance of social distancing rules. The third portion is immunized individuals which start from null and grow up as the infected individuals are recovering and building immunity amongst the population. When a large number of individuals become immune, they will protect other individuals not infected but susceptible and the pandemic may stop.[31]

The improvement process of herd immunity is shown in **figure 5.**

Relation between social distaining and Herd immunity:

In the case of a virus pandemic, social distancing is used as a social control strategy to reduce infection rates.[25] Governments and health care institutions normally instruct people to keep a minimum distance of 2 meters (6.5 feet) between each other when they are in crowded places.[46] Figure 5 illustrates the consequences of social distancing. In this scenario, the disease's spread would decline, which could eventually result in the outbreak of a pandemic. Ultimately the transmission chains of the virus will be broken and would result in slowing down the spread of the disease and reaching the pandemic peak with a smaller number of infected cases.[47] Limited health infrastructure able to provide proper treatment to infected people as the infected numbers declined. The social distancing concept is achieved by taking the difference between the current individual and a selected individual from the population which might be susceptible, infected, or immune.[31] It may impact herd immunity means if people are maintaining the social distaining carefully so that herd immunity may precede its impact upon a large number of populations easily by decreasing daily infected cases.

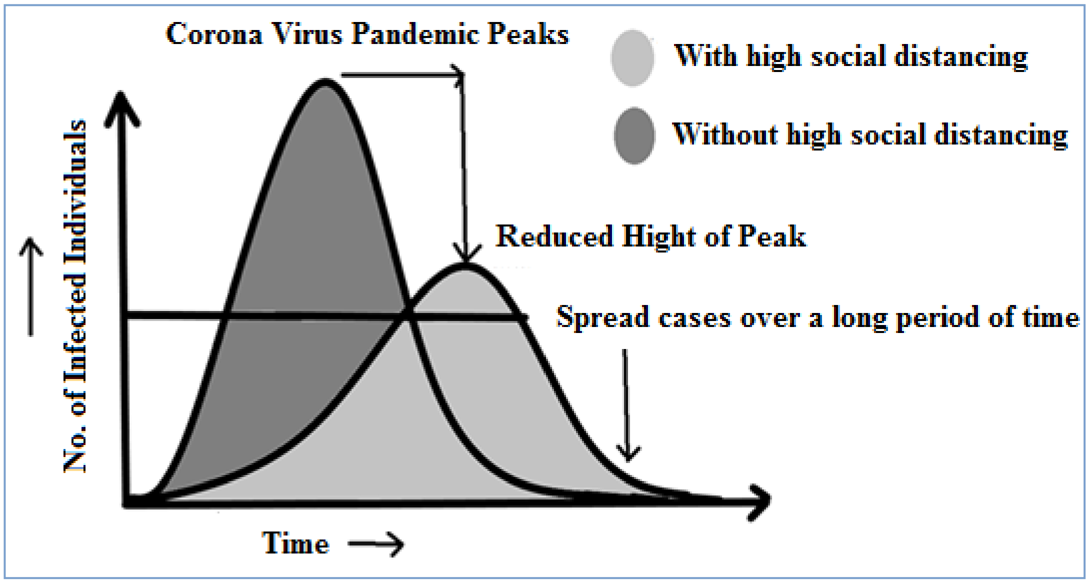

Figure 4: The impact of social distance on the spread of virus pandemics among the Population.[46]

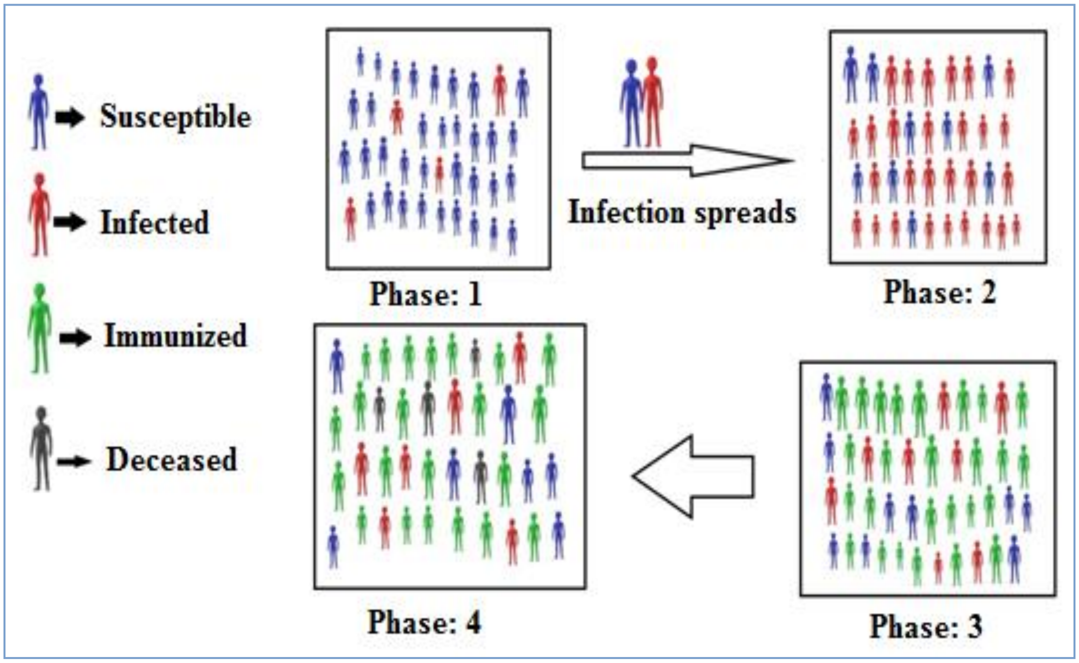

Figure 5: This graphic illustrates the progression of herd immunity in a population through phases 1 through 4.[31]

Effect of Microbiome on Herd Immunity

A key element to developing herd immunity in a population is maturing the immune system of every individual. Transient changes in microbiota, irrespective of the reason, could wreak havoc on the human immune system, disrupting vaccination and herd immunity programs.[32] Microbes, also known as the 'second brain' of the body, are numerous compared to the total number of cells in our bodies. About 99% of the total genome of humans comes from microbiota and only One percent comes from 23000 genes body's cells. The gut microbiota symbiosis significantly affects on function and development of innate and adaptive immunity.[15] The human microbiome regulates several functions in our body such as nutrient metabolism, developing and constructing immunity, intestinal barrier and made security against several diseases contributes to improving genetic diversity in populations.[48] Studies in Germ-free mice suggested that the absence of normal microbiota importunes the mutation of the immune system, affecting both structure and functions.[16]

Table 1 An overview of microbiomes that will have an indirect impact on the human immune system.

Name of Microbiomes	Contributions to the Human Immune System Indirectly
1. Bacteroides fragilis, a gram-negative bacterium.	It regulates mucosal tolerance to self-antigens by T-cell homeostasis, preventing T-helper-1 balance[49] and induces suppressive forkhead box p^{3+} T-regulatory cells functions by encouraging anti-inflammatory cytokines such as interleukin-10(IL-10) and transforming growth factor-β(TGF-β).[50]
2.Segmented filamentous bacteria (SFB)	Differentiation of Th-17 cells and Mucosal immunoglobulin -A (Ig-A) secretion is possible with the colonization of these bacteria.[51]

To achieve the best efficacy in vaccinations, microbiomes are crucial for infants born because their immune systems are still developing during their childhood (figure.5). The microbiome of an infant is determined by the exchange of microbiota between the mother and her offspring.[54] After three years, the microbiome is similar to the adult microbiome. After birth, it's highly variable for the first 3 years.[52] and grows uninterrupted, along with the development of the immune system.[16] The total microbiome composition of infants is mostly occupied by the phyla such as Firmicutes, Tenericutes Proteobacteria, Bacteroides, and Fusobacteria based on messmate microbiota shelters in the placenta.[53] The flora in the intestinal tract of babies born by vaginal delivery is similar to the flora in the vaginal canal of their mothers. They are prevalent with Lactobacillus sp. and Prevotella sp.[54] The most significant influence on changing the microbiome of children occurs after birth through milk-feeding. A bacterium called *Bifidobacterium* sp. (phylum Actinobacteria) occurs in large quantities in breast milk. In infants, it is abundant in the intestinal tracts. Also common in infants are *Staphylococcus* sp., *Streptococcus* sp., *Lactobacillus* sp., *Serrati* sp., etc. in their gut.[55] In contrast, there is a high concentration of aerobic bacteria and a lower prevalence of *Bifidobacterium* species in bottle-fed infants' guts.[56] The neonatal microbiota not only helps regulate metabolic functions but also helps to develop the native immune system, which eventually results in community immunity (herd immunity) by dominating a successive vaccination in a population.

Impact of Nutrient

Nutritional metabolism, microbiota, and vaccination effectiveness are influenced by Leptin signalling.[57] In addition, it modulates cellular immunity and regulates hunger threshold by establishing a balanced Th1/Th2 response.[58] and also suppressing Treg cell differentiation. Therefore, several metabolites are critical, as short-chain fatty acids (SCFAs) show an example of how nutrients processing by microbiota shapes the development of the immune system.[59] Vitamin A (Retinoic acids) presence in the diet has also been linked to the amplified frequency of *E. coli*, causing enteric infections. The imbalance of vitamin A causes amelioration of Th17 subsets in the small intestine, which is associated with increased SFB.[60] The impact of nutrients to help microbiota cannot be neglected.

Impact of Environmental Factors

Herd immunity is greatly influenced by environmental factors such as nutrients and the microbiome. European study documents that 87 million people suffer from allergies, and one in four children suffer from allergies. Around 40% of those with allergic rhinitis have asthma, and up to 90% of asthmatic patients have allergic rhinitis as well. In light of the impact of allergic rhinitis and asthma on the daily lives of patients and their families, the lay public must understand the concept of one airway.[17] Various changes in our environment, diet, water quality, and daily lifestyle have played a dominant role over the last 150 years, in the specificity of these diseases, as well as in their prevalence and severity.[18] Urban environments are strongly regarded as having various pollutants. As a result of exposure to various pollutants, microbiomes in the body become disturbed. According to the hygienic hypothesis, exposure to certain viral infections during early childhood and large family sizes reduce the risk of developing hay fever and allergic rhinitis.[19] Immunity's ability to shape an ideal system determines how successful a vaccination will be. Dietary changes and environmental factors can account for up to 57% of gut microbiota changes, affecting the immune system.[20] Modern lifestyle, and specifically a Western diet, has led to a substantial depletion of the human gut microbiome. This loss is implicated in the furious increase of chronic diseases, providing an incentive to fundamentally transform human nutrition towards being more holistic and microbiome-focused.[21] Westerners, therefore, have less microbial diversity in the gut because of diets high in saturated fats and low in fiber, which affect the microbiota frequency of humans.[22]

The degradation of the environment and its effects on human health render the human immune system less able to combat contagious community diseases such as covid-19. To do so, we need to reduce these harmful factors in the environment by transforming it into an environment that is free from pollutants, healthy, and liveable.

Herd immunity depends on the method of immunization through vaccination

A vaccine is an inactivated or attenuated pathogen or component of a pathogen (nucleic acid, protein) that provokes a protective response in the immune system when administered to the host.[61] The concept of vaccination, or immunization programs, and herd immunity are closely linked. The most effective examples have been achieved through various vaccination programs. Living or non-living agents are used in many vaccines, such as B-subunit-inactivated whole-cell combination vaccine, poliovirus vaccine, SC602 live Shigella flexneri 2a vaccine[24], In addition, the oral rotavirus vaccine (RVV) and CVD 103-HgR live cholera vaccine has produced different immune responses based on the route of immunization.

The theory behind vaccines and herd immunity states that by inducing immunity against infection, in a randomly mixed population which is consistent with the threshold for herd immunity can be represented as $Vc=(1-1/R0)$, where Vc is the critical minimum proportion to be vaccinated. The transmission is a complex process that can be explained through simplified models by, one parameter β that is the transmission coefficient. The intricate nature of β is explained by considering F (the force of infection), which represents the rate at which illness spreads among healthy individuals. I and S, the number of susceptible and infected people, determine this value. When the proportion of susceptible individuals drops below the threshold for transmission, it is called herd immunity. Threshold Herd immunity acts at this level to protect people susceptible to infection through indirect protection. The threshold for herd immunity is determined by the basic reproduction number, a parameter denoted as R0. This value indicates the contagiousness or transmissibility of an infectious or parasitic agent. The term basic reproduction number R0 denotes the number of new infections that can be spread by infected individuals to non-immune and susceptible contacts during the period of infectivity. It indicates the transmissibility of a virus. Another significant parameter in this context is the effective reproduction number (Re). The number of Secondary cases resulting from a single index case in an immune population during an infectious period is called Re. Re and Ro are different from each other. The dynamics of this parameter will probably change upon implementing a vaccination campaign. The vaccination programs aim to achieve herd immunity. It occurs when the proportion of people with immune systems in a population surpasses the herd immunity threshold; the pathogen spread is interrupted and the number of infections declines.

According to Dr. Galit Alter, a professor of medicine and a group leader at the Ragon Institute of MGH, MIT, and Harvard, many covid19 vaccine developers decided instead to focus their attention on a specific part of the coronavirus, which is the virus spike, rather than the entire virus as a potential platform for driving immunity. Covid 19 vaccines are currently available in three main types: -

mRNA vaccines: mRNA vaccines have been developed by Pfizer and Moderna. It is responsible for producing proteins that are released from the cell. The immune system picks up these particles and instructs the B cells, or antigen-producing machines, to produce lots of antibodies to combat the infection.

Vaccines derived from inactivated viral vectors**:** As an example, there are the Adenoviral vaccines, such as the ones from Sputnik and Johnson & Johnson. In this way, the body is exposed to the coronavirus spike protein, thereby naturally creating antibodies against that target.

The inactivated SARS-COV-2: The Chinese Sinopharm vaccine is currently being produced using this method. Viruses reach the immune system in their complete form but are not infectious unless they are activated.

Herd immunity real cases in several countries against covid-19:

Herd immunity can be used to combat COVID-19 in some countries like:

To achieve herd immunity, Sweden kept its schools, restaurants, and businesses open and asked its citizens to practice social isolation voluntarily.[26] The Swedish herd immunity takes longer than expected.[27] From 3 January 2020 to 17 June 2021, there have been 1,084,636 confirmed cases of COVID-19 with 14,574 deaths, reported to WHO. As of 12 June 2021, a total of 6,426,443 vaccine doses have been administered (WHO Sweden data, 2021).

The UK allows the spread of the virus to increase the population herd immunity while protecting the elderly because they are the most vulnerable to this virus.[23-28] The UK government recommended using herd immunity to contain COVID-19.[29] As shown in Figure 4, the number of confirmed cases for the UK declined between February to May 2020, as well as the number of deaths. As of June 28, 2020, the UK has 310,254 confirmed cases and 43,514 deaths (World Health Organization, 2020 Covid-19 UK data).

US AMERICA - Due to the negative response to the fight against COVID-19, the epidemic situation in the United States had attracted global attention and it became evident that people were not sure whether to use "Herd immunity" as a response strategy or not. WHO monitoring data on COVID-19 shows that new cases of infection in the United States were down in June, but increased in July. It should be connected to reactivating the economy. At present, the United States has the highest number of confirmed cases in the world, with new cases being reported every day.[62] From March 2, 2020, to June 7, 2020; there are total confirmed cases 33163632 and total death cases 595256. At the beginning of 2020, the weekly increase was 28.28% and end of May it declined to -35.47%. As of 10 June 2021, a total of 309,004,429 vaccine doses have been administered (WHO covid-19 US data, 2021).

India - Early in April 2020, COVID-19 mortality is predicted to be lower than worldwide standards, and COVID-19's overall impact may not be so significant in India. The number of cases of COVID-19 in India has increased in the past six months in 2020. Contrary to the case numbers, however, mortality has been consistently decreasing since mid-May, from a peak of 3.7% to as low as 1.5% (WHO India report, 2020). Although the mortality ratio is expected to continue dropping even after the country opened its cities, transportation, and communications since 1st June, the trend is indicating that it can decrease further. There is a possible explanation for this increase in COVID-19 cases due to an increase in testing rates among asymptomatic and mildly symptomatic patients. A serological survey provides further evidence that India has a low infection mortality ratio. Testing has been done by accredited private laboratories in several Indian cities, though without random sampling and based on on-demand requests. The Indian Council of Medical Research (ICMR) has approved IgG ELISA kits to be used in random sample selection in metropolitan cities in India. Most of these survey findings have only been published in newspapers and on electronic media, not in peer-reviewed journals, but just about all claim between 15-30% positivity in healthy asymptomatic individuals. This can be seen as an indication that many Indians have been infected with SARS-CoV-2 already, recovered from the infection, and developed antibodies to it before being aware that they had been infected; the process leading to the development of herd immunity.[30] An ICMR study published in late September 2020 based on findings from a country-wide serosurvey conducted between May and June 2020, there was only a 0.15% infection fatality rate in districts with presumed robust death reporting. When compared with the other major diseases prevalent in India, this amount appears quite insignificant.[30]

As in many parts of the world, especially Europe, India has seen a massive rise in cases and deaths associated with COVID-19. Taking into account USA's and Brazil's identified cases;

India is the 3rd most-affected country as of April 10, 2021. A second wave started in mid-March 2021, and by April 9th, India had identified the largest number of cases (144,829) according to Worldometer, COVID-19 coronavirus pandemic, 2021. In India, from 3 January to 17 June 2021, there have been 29,700,313 confirmed cases of COVID-19 with 381,903 deaths, reported to WHO and at the end of June 1st week,2021 decreased to -31.07%. As of 14 June 2021, a total of 261,740,273 vaccine doses have been administered (WHO covid-19 report India, 2021).[63]

As per several countries' reports, a decline of daily confirmed cases and infection rate may occur due to immune from the natural infection and vaccination which can impact upon Herd Immunity in a huge number of populations.[64,65]

Conclusion

Almost no one was immune when the coronavirus that causes COVID-19 first spread. The virus spread rapidly throughout communities as it encountered no resistance. For it to be stopped, a significant percentage of people will need to be immune. By vaccinating more people, we reduce the chance of the virus spreading in the population, and that means we are closer to herd immunity.

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