An In-Depth Analysis of the Novel SARS-CoV-2

Joseph Younan

University of California, Merced

Author Note

This paper was prepared for Writing 100: Advanced Writing taught by Prof. Susan Miller.

Abstract

The COVID-19 outbreak, originating in China and spreading across the globe, has affected the entire world by taking the lives of millions and leaving millions more in hospital beds fighting for their lives. This infectious disease was considered a pandemic by the World Health Organization (WHO) in March of 2020, and since then has created an urgent response from world leaders and health organizations to develop an effective strategy to overcome this deadly disease and put an end to the pandemic. Several techniques have been developed by health organizations and vocalized by world leaders around the world which have all been helpful in the fight against COVID-19, however this article looks to address how living a healthy lifestyle might also be one of the most important techniques that should be implemented and vocalized in order to put an end to this novel virus. Research has shown that continuous physical activity and healthy eating habits have been and continue to be one of the most effective ways in protecting individuals from severe outcomes after infection with SARS-CoV-2. These practices must be adopted by every individual in order to defeat this disease and ultimately put an end to the COVID-19 pandemic.

The Origins of COVID-19

Popularly known as “The Coronavirus”, the World Health Organization (WHO) depicted this virus as a type of coronavirus known as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). SARS-CoV-2 is an airborne virus that originated from China and has rapidly caused the worldwide, COVID-19 pandemic. Cases, hospitalizations, and deaths related to COVID-19 have exponentially increased starting around December of 2019 and as of November 2021, this virus has taken over four million lives worldwide and continues to become a threat around the globe (Murphy & Wu, 2021). As everyone around the world has had their lives affected by this outbreak, the main questions to be asked are what exactly SARS-CoV-2 is and how does it work.

SARS-CoV-2 is one of many known coronaviruses, which trigger a respiratory tract infection (Wiersinga et al., 2020). According to a study conducted by Wiersinga et al. (2020), major negative effects can come from respiratory infections on organs including the nose, throat, windpipe, and lungs (Wiersinga et al., 2020). Most coronavirus diseases are not dangerous and are quite common. The study mentions that many other types of coronaviruses, which may cause the common cold, are not too serious regarding healthy individuals and that SARS-CoV-2 is a novel coronavirus because of how communicable it is and the threat it poses to human health (Wiersinga et al., 2020). The article goes on to discuss how the transmission of this virus occurs through the inhalation or the direct contact of water droplets that may carry the virus to bodily openings and that the incubation period of COVID-19 is 2-14 days after exposure to SARS-CoV-2 (Wiersinga et al., 2020). Carriers of COVID-19 may be symptomatic or asymptomatic which means that individuals infected with the disease may or may not show signs of symptoms as Wiersinga et al. (2020) goes on to explain. Symptoms of COVID-19 may include, but are not

limited to, a fever, cough, or loss of taste and smell (Wiersinga et al., 2020). The outbreak of SARS-CoV-2 became increasingly dangerous during the period of when it was first detected in China as the virus was threatening to spread across the globe and in March of 2020, COVID-19 was ultimately considered a pandemic by the WHO since the virus was spread across multiple countries and has affected a large portion of the population (Wiersinga et al., 2020). As nations all around the world have been affected by SARS-CoV-2 and countless lives have been lost to the disease, research has been designed to gain a better understanding of how SARS-CoV-2 works to affect the human body and what efforts can be implemented to prevent this virus from continuing to take the lives of loved ones around the globe.

Coronaviruses are unique viruses in their pathophysiology. By definition of a virus, coronaviruses work to invade host cells and adapt to host defense mechanisms through genetic recombination as Wiersinga et al. (2020) states in a research article. These viruses are large, about 60 nm to 140 nm in diameter, and are single-stranded RNA viruses found mainly in mammalian animals (Wiersinga et al., 2020). The article mentions that the spike proteins found on the virus give it a crownlike appearance under a microscope, which is where the name coronavirus came from (Wiersinga et al., 2020). They bind to healthy cells and infect them similarly to the influenza virus (Wiersinga et al., 2020). Although the pathophysiology of the novel coronavirus is remarkably like other diseases that cause similar infections, the infection rate and effect on human health is none like any other. As the SARS-CoV-2 virus which causes COVID-19 is a novel virus that has had no prior contact with the human immune system unlike other common viruses such as influenza or the common cold, this leaves the human body prone to damage as the immune system will not be able to immediately recognize the foreign pathogen when it enters the

body, and thus as a result is labeled as a highly contagious virus with a soaring infection rate (McCrimmon, 2020).

Regarding future research and medical discoveries made to favor human health and defense against this disease, it is important to understand the structural and functional aspects of SARS-CoV-2 to designate a plan to defend against. As scientists continue their research on this novel virus, being able to gain knowledge on how the SARS-CoV-2 virus is made up structurally can allow scientists to further develop strategies to combat the virus and prevent it from spreading rapidly. Comparing and contrasting the structural makeup of this novel virus with other types of viruses such as the influenza virus which causes the common flu can allow researchers to obtain critical information as to how COVID-19 functions and effects human health which will ultimately allow scientists to come up with advanced techniques and medications to combat this novel virus more efficiently. These distinct aspects of SARS-CoV-2 can help address COVID-19 to gain a better understanding to help fight this disease.

The Human Immune Response and Mechanisms to COVID-19

The immune system is a complex network of organs and cells that work to fight off foreign invaders that may enter the body as Oliveira et al. (2020) describes in an article. While doing so, it will work to remember every disease it has defeated to alleviate it more efficiently if it were to enter the body again (Oliveira et al., 2020). The article states that when SARS-CoV-2 enters and infects the body, T-lymphocytes (T-cells) which are primarily located within bone marrow will become active as soon as the pathogen is recognized (Oliveira et al., 2020). These T-cells will work to locate and eliminate any cell that has been infected with the detected virus (Oliveira et al., 2020). The study continues to explain that after the virus has been eliminated, the immune system will begin to slowly decrease the activation of T-cells leaving the human

body free of any harm from foreign pathogens (Oliveira et al., 2020). After the immune system's T-cells have had initial contact with the virus, antigen-specific memory T-cells are developed (Oliveira et al., 2020). As stated by Oliveira et al. (2020), memory T-cells recognize and collect the information of the specific SARS-CoV-2 antigens, identification protein tags that are found on foreign invaders, to store that information into the immune system's memory for future reference (Oliveira et al., 2020). If one was infected with SARS-CoV-2, the individual developed some immunity to the virus and the chances of developing severe symptoms to COVID-19 a second time is highly unlikely. When needed to fight off SARS-CoV-2 more efficiently, the body's memory T-cells will have the mechanisms in place to recall the identity of SARS-CoV-2 and signal to other immune system components to fight off the virus in a timelier manner (Oliveira et al., 2020). The immune system is a natural defense mechanism that can help save lives against COVID-19 and keeping this network of organs and cells healthy and active is a major step towards defeating this novel virus.

Depending on the individual's immune system, infection due to COVID-19 will differ based on one's set of symptoms from their medical condition. In a study conducted by Oliveira et al. (2020) which looks into the human body's immune response due to COVID-19, they state that a major variable that contributes to the human immune response is their symptom severity level. The defined symptomatic severity levels include being asymptomatic, mildly symptomatic, and severely symptomatic (Oliveira et al., 2020). The research article explains how asymptomatic COVID-19 carriers are positive for COVID-19 and show no symptoms of the disease, however, may still be able to spread the disease since water droplets from asymptomatic carriers can still contain the virus and enter the bodies of other individuals through bodily openings such as the eyes, nose, or mouth (Oliveira et al., 2020). Mildly symptomatic COVID-19 carriers may

show symptoms of infection which include having a fever, dry cough, shortness of breath, headache, and a sore throat. Similarly to asymptomatic carriers, mildly symptomatic carriers of COVID-19 can spread the virus through water droplets (Oliveira et al., 2020). Finally, the study explains how severely symptomatic COVID-19 carriers may show symptoms of infection which include, but are not limited to, having a rapid heartbeat, rapid breathing, and low blood-oxygen levels (Oliveira et al., 2020). Most of the time, individuals with severe symptoms due to SARS-CoV-2 infection will require treatment in the intensive care unit (ICU) as these individuals are in danger of developing pneumonia or organ failure. Patients with chronic illnesses or underlying conditions including high blood pressure, diabetes, heart disease, lung disease, and cancer are at major risk for developing severe symptoms after a COVID-19 infection, which could result in death (Oliveira et al., 2020). Symptom severity levels of COVID-19 may vary depending on the individual's immune system and how efficiently it works to fight off the SARS-CoV-2 virus after entrance into the human body.

The Production and Efficacy of Vaccines Against COVID-19

The human body’s immune system is designed to stave off pathogens that may enter the body, including COVID-19. Through scientific advances, humans have used technological platforms to prepare and safely expose the body’s immune system for such invaders before they enter the body as explained in an article released by the WHO (2020). For example, vaccines in the form of liquid shots that inject an inactive form of a virus into the human body cause an individual’s immune system to create antibodies against a certain disease by making it think that the actual virus has entered the body (WHO, 2020). This allows the immune system to have prior exposure to the disease and be ready to fight and eliminate a pathogen entering the body (WHO,

2020). As of November of 2021, there have been a total of three vaccines created and manufactured in the United States to help the immune system develop immunity against a SARS-CoV-2 infection. The companies of Pfizer, Moderna, and Johnson & Johnson have all been granted an Emergency Use Authorization (EUA) by the Food and Drug Administration (FDA) to begin production of their respective COVID-19 vaccines for the public to put an end to this pandemic (FDA, 2021).

There are several different ways vaccines can be implemented to prepare the human body's immune system to fight off infectious diseases if they were to enter the body and invade healthy cells. The oldest type of vaccine ever created was used to protect against smallpox around the 1800s and used an attenuated virus to create protection after injection into the human body ("History", 2021). The study by Forni and Mantovani (2021) explains how this class of vaccines uses a living microbe, a microorganism that causes a disease, that has been weakened so that it does not cause any significant harm to the patient (Forni & Mantovani, 2021). Even though this type of vaccine is shown to create lasting immunity against the infectious disease, it is known to cause rare but severe side effects since attenuated viruses can still cause diseases (Forni & Mantovani, 2021). Regarding vaccines that have been created to fight off a SARS-CoV-2 infection, there are currently none available in the United States as of November 2021 that implement this type of vaccines, however, a study is being done to test a vaccine that uses a live attenuated virus in humans to prevent COVID-19 which is known as COVI-VAC ("Safety", 2021).

The most common and traditional types of vaccines that have been used to obtain immunity against infectious diseases are those that are based on inactivated viruses. Examples of vaccines mentioned in the study by Forni and Mantovani (2021) that use inactivated viruses include

the whooping cough vaccine, rabies vaccine, and the polio vaccine. Vaccines produced using this method are more stable but less effective than attenuated based vaccines (Forni & Mantovani, 2021). In their research, they explain how immune memory corresponding with the inactivated viruses have a short duration so more amounts of the vaccines need to be injected to compensate for the short time span of immune memory. Candidates that are in the process of creating COVID-19 vaccines based on the inactivated SARS-CoV-2 virus include many companies that are based in China such as Sinovac Biotech and other Chinese based institutions (Forni & Mantovani, 2021).

Moving away from the usage of actual weakened or inactive viruses, a new technologically advanced type of vaccine which uses mRNA to develop immunity has made its way to the production and manufacturing stage of the race to vaccinate the world. Forni and Mantovani (2021) mention the implementation of messenger RNA based vaccines which have never been created until now with today's advanced technology and knowledge. Once inoculated into the body, the mRNA contained in the vaccine causes the cells in the body to produce antigen proteins and antibodies which is coded by the mRNA (Forni & Mantovani, 2021). These instructions provided by the mRNA code for the same genetic instructions for the spike protein on the actual SARS-CoV-2 virus, which causes the immune system to create antibodies designed to target the exact antigen on the actual SARS-CoV-2 virus if it were to ever actually enter the body (Forni & Mantovani, 2021). The genetic material created from the mRNA vaccines are then destroyed by the human body's cells after antibodies have been created ("Different COVID-19", 2021). Frontrunners regarding this type of vaccine include Pfizer and Moderna which are the main vaccines available in the United States for Emergency Use Authorization with the Pfizer-

BioNTech COVID-19 mRNA vaccine becoming the first vaccine created to aid in the fight against the COVID-19 pandemic (“Different COVID-19", 2021).

The final main type of vaccine created to aid in the fight against COVID-19 are vaccines based on viral vectors. The study by Forni and Mantovani (2021) explains how these types of vaccines use the DNA coding belonging to the spike proteins on the actual SARS-CoV-2 virus which can then be made into viral vectors and inoculated into the body for the immune system to begin its process of creating antibodies (Forni & Mantovani, 2021). Candidates include Johnson & Johnson and AstraZeneca which are mainly available in the United States and Europe respectively (Forni & Mantovani, 2021). The vaccines that have been created using viral vectors to fight off a SARS-CoV-2 infection contains a modified version of the virus that differs from the one that causes COVID-19 (“Different COVID-19", 2021). The shell of the modified virus contains material from the actual virus that causes COVID-19 which ultimately allows the human body’s immune system to recognize this genetic material and create protection through T-cells and antibodies (“Different COVID-19", 2021). There have been many other types of vaccines created and are currently in clinical trials which have also proven to be effective against a SARS-CoV-2 infection, all of which will help in ultimately putting an end to the COVID-19 pandemic.

The efficacy rate and how its assessed is also a major aspect regarding clinical trials and manufacturing of these vaccines. When looking at how effective each vaccine is for protecting individuals against COVID-19, scientists use Phase III human trials to test for T-cell activation and a high immune response after inoculation (Forni & Mantovani, 2021). The study explains that evaluation is based on randomized controlled trials that compare the events of infection with the SARS-CoV-2 virus in large groups of vaccinated and unvaccinated individuals. This trial will

then determine whether the vaccine or multiple vaccines are indeed effective against the infectious disease and will be assessed to see exactly how effective each vaccine is in creating an immune response as well as protecting individuals (Forni & Mantovani, 2021). There are also many unknowns that accompany the COVID-19 vaccines that are being created by scientists and companies all around the world. Information and studies based on how long immunity lasts after inoculation, whether booster shots will be needed after being fully vaccinated, and how long after being fully vaccinated will booster shots need to be administered are all questions that health organizations and scientists are being asked by the public (Forni & Mantovani, 2021). As further research and more information is available, these questions will all soon be answered with evidence to back them up through clinical trials and tests. Vaccines are arguably the most efficient and critical way of putting an end to the COVID-19 pandemic and ultimately saving the lives of thousands.

As the COVID-19 pandemic progresses, mutations of the original SARS-CoV-2 virus are highly likely to occur and have already occurred throughout the world according to a recent article by Pearson (2021) explaining the different COVID-19 variants. She states that mutations are simply errors or typos that occur in the genome of the virus as it copies itself and replicates while moving from person to person (Pearson, 2021). These mutations are usually more harmful than the original virus and are prone to causing more damage and leaving a greater toll on populations (Pearson, 2021). The article also mentions that as multiple variants arise from around the world and progress to a dangerous level of new cases involving those newly discovered variants, questions arise about the vaccine efficacy regarding these variants and whether the vaccines that are currently authorized for emergency use will even protect us against them. Pfizer and Moderna

are two of the main vaccine companies that are seen to provide protection against emerging variants of the SARS-CoV-2 virus (“Different COVID-19", 2021). Some other variants, however, are still in their preliminary stage of research and scientists are not sure whether the currently available vaccines protect against them (Pearson, 2021). This article also looks at the many different mutations associated with the virus and vaccination efforts, as well as how human immunization can prevent infection and severe symptoms

Healthy Habits to Protect Oneself From COVID-19

The COVID-19 pandemic has affected everyone in the world no matter the age group. Measures have been taken mandated by health organizations such as the CDC and WHO to protect individuals from becoming infected and threatening the well-being of humanity. Mandates including social distancing, facial coverings, and complete lockdowns have all been enforced on citizens of every country in the world to regulate and control the positivity rate of infections and rising hospitalization numbers as well. The gap regarding COVID-19, however, that health organizations and authorities are failing to address is the fact that human health is one of the major aspects to surviving possible infection and not developing severe outcomes when becoming infected with COVID-19. Physical activity and healthy eating habits are one of the main ways to protect oneself from developing severe outcomes after infection (Ambrosini, 2020). In an interview with Ambrosini (2020) regarding COVID-19, Dr. Greger explains how severe outcomes regarding this infectious disease all relate to underlying conditions such as diabetes, heart disease, and obesity which can all be reversed and resolved by following a healthy plant-based diet and lifestyle (Ambrosini, 2020).

Physical activity has been said to be the second-best way to protecting oneself from this infectious disease and reducing chances of developing severe outcomes due to COVID-19 only

next to being vaccinated (Sallis et al., 2021). A study from Dr. Sallis et al. (2021), a distinguished professor from UC San Diego, worked with a physician out of Kaiser Permanente along with other researchers to find out whether physical activity and exercise helps the immune system fight off COVID-19 the same way it helps the immune system fight off other infections. Kaiser was able to help with this study since they already track their patient's physical activity like it's a vital sign. The study had three groups of patients, each group with increasingly more minutes of physical activity than the other group. What the research found was that the inactive group was more likely to be hospitalized and die due to COVID-19 than the two above groups that had more physical activity minutes per week. The research went on to ultimately conclude that being physically inactive poses a higher risk for developing severe COVID-19 outcomes than having certain underlying medical conditions (Sallis et al., 2021).

Physical exercise has been proven to boost immune function as it affects the activity of the immune system when dealing with a pathogen (Da Silveira et al., 2021). Certain aspects of the immune system are directly affected by physical activity as explained in a research article by Da Silveira et al. (2021). The research article states that cytokines, which are classified as either anti-inflammatory or pro-inflammatory signaling molecules, see an increase in levels when muscle contractions are performed due to intense exercise and physical activity (Da Silveira et al., 2021). Another aspect of the immune system that being physically active directly affects are natural killer cells. The research suggests that cellular stress brought by exercise has known to recruit natural killer cells since blood flow is significantly increased (Da Silveira et al., 2021). Neutrophils are also known to dramatically increase in concentration due to physical activity (Da Silveira et al., 2021). Muscle fibers activated by exercise cause the release of calcium and therefore boost the production of cytokines (Da Silveira et al., 2021). Physical activity is one of the

main ways an individual can boost their immune system to help protect and defend themselves from infectious diseases such as COVID-19.

The COVID-19 pandemic has taken a heavy and negative toll on the whole globe, taking thousands of lives and hospitalizing millions in the process. Gaining knowledge and understanding how this infectious disease works to damage and harm the human body is a major step towards defeating it and putting an end to the pandemic. As more research is conducted to find answers, there have been many ways implemented and explained by major health organizations and authorities to help us bring an end to this virus. Strategies including developing a vaccine and authorizing social mandates have all done their part in protecting people. Society must do their role and play their part in flattening the curve to protect themselves and others. As the pandemic continues to take lives and injure citizens, it's important to remember that every individual has a part to play in getting the world back to normal and ultimately saving millions of lives. Finally, this article aims to address a major gap in research related to this topic, namely how a healthy lifestyle can significantly reduce the chance of serious consequences after being infected with COVID-19.

Discussion and Future Research Proposals

COVID-19 has affected the entire world health-wise, and it is important to follow guidelines mandated by health organizations and medical professionals to slow the spread and save lives from this novel virus. There are many ways to prevent this virus from taking a further toll on the world and it is up to whether society wants to do its part in preventing it. With this research, I hope to discover ways in which this virus works to invade cells and ways in which this virus can be ceased via our natural immune system as well as through the vaccines that have been created. I also hope to gain more knowledge about the various variants and how well the

vaccines work to fight against these strains. Finally, I want to discover how a healthy lifestyle can help fight this disease. Gaining knowledge on the subject is essential for treating patients, manufacturing vaccines, and taking safety measures to protect ourselves and those around us. The information found and the methods used to address these topics are all done through literature reviews of academic articles and other reliable sources from databases such as Google Scholar and NCBI.

References

Ambrosini, M. (2020, September 16). *Do You Know How To Stay Healthy & Survive A Pandemic? Dr. Michael Greger Shares His Expert Tips* [Video file]. Retrieved July 30, 2021, from https://www.youtube.com/watch?v=Fq_4WLpe5DU&t=2173s

CDC. (2021, November 9). *Different COVID-19 vaccines*. Centers for Disease Control and Prevention. Retrieved November 12, 2021, from https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines.html.

CDC. (2021, February 20). *History of smallpox*. Centers for Disease Control and Prevention. Retrieved November 15, 2021, from https://www.cdc.gov/smallpox/history/history.html.

CDC. (2021, July 28). *Safety and immunogenicity of Covi-VAC, a live attenuated vaccine against COVID-19 - Full Text View*. ClinicalTrials.gov. Retrieved July 28, 2021, from https://clinicaltrials.gov/ct2/show/NCT04619628.

Da Silveira, M., Da Silva Fagundes, K., Bizuti, M., Starck, É, Rossi, R., & De Resende E Silva, D. (2021, February). *Physical exercise as a tool to help the immune system against COVID-19: An integrative review of the current literature.* Retrieved July 30, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7387807/

FDA. (2021, November 9). *Covid-19 vaccines*. U.S. Food and Drug Administration. Retrieved November 12, 2021, from https://www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/covid-19-vaccines.

Forni, G., & Mantovani, A. (2021, January 21). *COVID-19 vaccines: Where we stand and challenges ahead.* Retrieved July 30, 2021, from https://www.nature.com/articles/s41418-020-00720-9

Murphy, J., & Wu, J. (2021, November 10). *Map: Track coronavirus deaths around the world*. NBCNews.com. Retrieved November 11, 2021, from https://www.nbcnews.com/news/world/world-map-coronavirus-deaths-country-covid-19-N1170211.

Oliveira, D., Medeiros, N., & Gomes, J. (2020, November). *Immune response in COVID-19: What do we currently know?* Retrieved July 30, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7480770/

Pearson, C. (2021, February 25). *What's the difference between all the new covid-19 variants?* Retrieved July 30, 2021, from https://www.huffpost.com/entry/difference-between-new-covid-variants_l_602d621fc5b6cc8bbf38c192

Sallis, R., Young, D., Tartof, S., Sallis, J., Sall, J., Li, Q., . . . Cohen, D. (2021, April 08). *Physical inactivity is associated with a higher risk for Severe covid-19 outcomes: A study in 48 440 adult patients.* Retrieved July 30, 2021, from https://bjsm.bmj.com/content/early/2021/04/07/bjsports-2021-104080

WHO. (2020, December 8). *How do vaccines work?* World Health Organization. Retrieved November 12, 2021, from https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work

Wiersinga, J. W., Rhodes, A., & Cheng, A. C. (2020, August 25). Coronavirus Disease 2019 (COVID-19)-Epidemiology, Diagnosis, and Treatment. JAMA. https://jamanetwork.com/journals/jama/fullarticle/2768391