

# VCHEI SCIENCE CLUB

Vigilance Of Contemporary Health And Environmental Issues

**END OF SCHOOL YEAR 2021/2022**

REPORT ON INDIVIDUAL LITERATURE  
STUDY & GROUP DISCUSSION

TOPIC : **COVID-19 PANDEMIC**

**June, 2022**







CORONAVIRUS  
RESEARCH



KEEP YOUR  
DISTANCE



USE OFFICIAL  
INFORMATION



CALL THE HOSPITAL  
IF SYMPTOMS APPEAR



HOME  
QUARANTINE



INCUBATION  
PERIOD



INDIRECT  
CONTACT



LOCALIZATION  
OF CORONAVIRUS



DISINFECT  
HANDS



USE  
FACE MASK



DISINFECT  
SURFACES



WASH  
HANDS



USE  
RUBBER GLOVES



COMPLICATION  
VIRAL PNEUMONIA



DIRECT  
CONTACT



DISINFECT  
HANDS





FEVER  
OFTEN



DRY COUGH  
OFTEN



HEADACHE  
RARELY



SORE THROAT  
RARELY



RUNNY NOSE  
RARELY



DYSPNEA  
RARELY



AIRBORNE DROPLET  
TRANSMISSION



CONSULT  
A DOCTOR



DO NOT  
SELF-MEDICATE



AVOID  
CROWDS



DON'T  
SHAKE HANDS



DON'T  
WALK



DON'T  
TOUCH FACE



COVER  
YOUR MOUTH



STOP  
COVID-19



STOP  
COVID-19



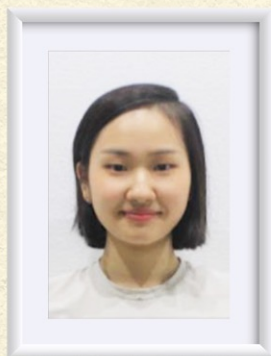




## CREATORS



Author 1  
**Juwon Park**  
11<sup>th</sup> Grader  
*Mountainview  
Christian School*



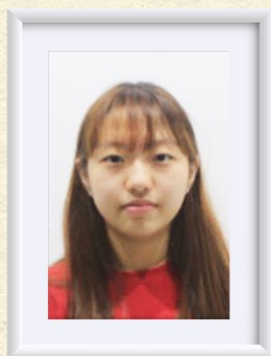
Author 2  
**Ju Young Oh**  
11<sup>th</sup> Grader  
*Mountainview  
Christian School*



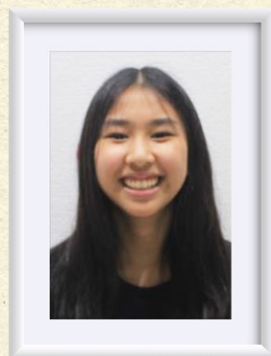
Author 3  
**Eugenia Trosmada**  
11<sup>th</sup> Grader  
*Mountainview  
Christian School*



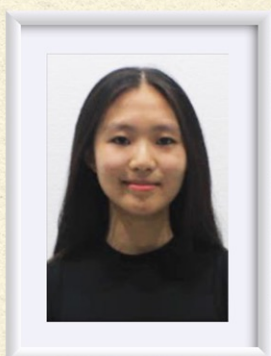
Author 4  
**Hui Min Mak**  
10<sup>th</sup> Grader  
*Mountainview  
Christian School*



Author 5  
**Cris Lee**  
11<sup>th</sup> Grader  
*Mountainview  
Christian School*



Author 6  
**Cherish Andreea**  
9<sup>th</sup> Grader  
*Mountainview  
Christian School*



Author 7  
**Yoon Jin Kim**  
10<sup>th</sup> Grader  
*Mountainview  
Christian School*



Editor  
**Debora W. Nuhamara**  
Science Teaching Assistant  
*Mountainview  
Christian School*



Graphic Designer  
**Vera Vellina**  
Lecturer  
*Universitas  
Multimedia Nusantara*



## TABLE OF CONTENTS

<b>Editor, Authors, and Graphic Designer.....</b>	<b>1</b>
<b>Table of Contents .....</b>	<b>2</b>
<b>Introduction.....</b>	<b>4</b>
Worldwide Cases of COVID-19.....	4
Coronavirus Transmission Routes.....	4
Measures To Prevent Transmission.....	5
Vaccines for COVID-19.....	5
COVID-19 Variants.....	5
Research and Discussion Topic.....	6
<b>How does SARS-CoV-2 affect our body and how different it is with the omicron variant? - by Juwon Park.....</b>	<b>7</b>
Background.....	7
SARS-CoV-2 lifecycle and mechanism.....	7
Immune response to SARS-CoV-2 infection.....	9
Mutation of SARS-CoV-2 & the omicron variant.....	10
Final Thoughts.....	11
Appendix 2.1. Omicron Spike Protein Mutation.....	12
<b>How does the vaccine regulations effect the spread and deaths of COVID-19 in South Korea? - by Ju Young Oh.....</b>	<b>13</b>
Background.....	13
Findings.....	13
Discussion.....	14
Conclusion.....	15
<b>How does COVID-19 patients chest CT result differ from the healthy ones? - by Eugenia Trosmada.....</b>	<b>16</b>
Background.....	16
Findings.....	16
Discussion.....	17
Conclusion.....	18
<b>How effective are lung transplants for covid-19 patients? - by Hui Min Mak.....</b>	<b>19</b>
Background.....	19



Findings.....	20
Discussion.....	21
Conclusion.....	21
<b><i>What are the medicines uses for COVID-19 patients? - by Cris Lee.....</i></b>	<b><i>22</i></b>
Background.....	22
Findings.....	22
Discussion.....	24
Conclusion.....	25
<b><i>How do supplements help our body fight against COVID-19? - by Cherish Andreea.....</i></b>	<b><i>26</i></b>
Background.....	26
Effects of Supplements on COVID-19 .....	26
Conclusion.....	28
<b><i>What are the effects of the massive use of masks and sanitation products during the COVID-19 pandemic on the environment? - by Yoon Jin Kim.....</i></b>	<b><i>29</i></b>
The Use of Mask and Sanitation Products during COVID-19 Pandemic.....	29
Environmental Consequences of Mask and Sanitation Product Wastes.....	29
Suggestion.....	31
<b><i>References.....</i></b>	<b><i>32</i></b>
<b><i>Postface.....</i></b>	<b><i>38</i></b>



# INTRODUCTION





## Early Outbreak of COVID-19

In late December 2019 in Wuhan, China, a new (novel) coronavirus was identified. The virus caused severe respiratory disease which includes pneumonia. Since then the virus is spreading between people globally and on March 11, 2020, the World Health Organization (WHO) has declared the novel coronavirus (COVID-19) outbreak as a global pandemic. The virus causing the infection has been named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease caused by the infection is named coronavirus disease (COVID-19) and has been categorized as a high consequence infectious disease (ICM Anaesthesia COVID-19, n.d.).

## Worldwide Cases of COVID-19

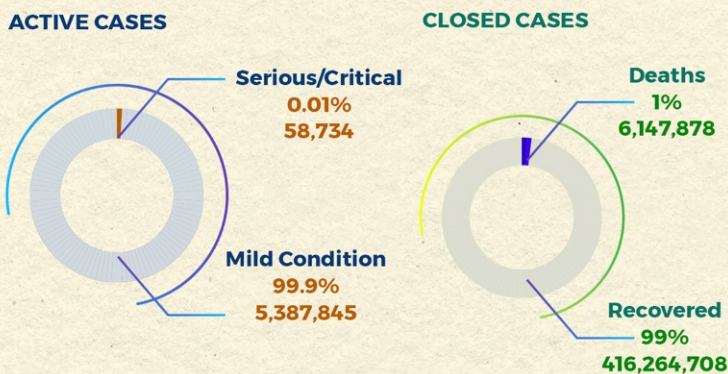
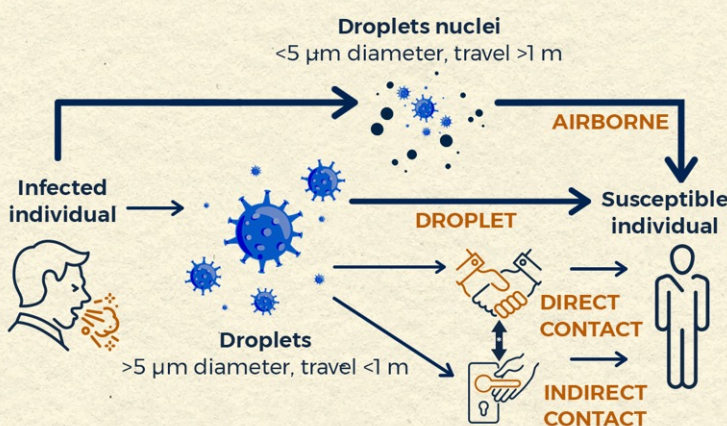


Figure 1.1. COVID-19 Cases Around the World (28th March 2022)  
\*Note: Statistics from Worldometer (n.d.)

As number of COVID-19 cases keep increasing rapidly since its first emergence, there are many organizations and sites that keep track on updating the data of COVID-19 cases. Statistic from Worldometer (n.d.) shows that as per March 2022, COVID-19 cases has reached more than 420 million around the world and even though the

percentage of deaths from the disease is as low as 1%, it is still a devastating situation that had taken away the lives of more than 6 million people around the world.

## Coronavirus Transmission Routes



\*Transmission routes involving a combination of hand & surface = indirect contact.

Figure 1.2. Coronavirus Transmission Routes  
\*Note: Adapted from Otter et al., 2015

Sars-CoV-2 spreads through three main ways:

- Inhaling air when being near to an infected person who exhales small droplets and particles that contain the virus.
- Having these small droplets and particles containing virus land on our eyes, nose, or mouth, especially through splashes and sprays like a cough or sneeze.

- Touching eyes, nose, or mouth with hands that contacts the virus on air or surfaces that has the virus.

Being 6 feet closer to an infected person would most likely get us infected (CDC, 2021).



## Measures To Prevent Transmission



Figure 1.3. Measure to prevent transmission  
\*Note: Adapted from WHO (2020)

- Wearing a mask could prevent us from transferring virus to other people when we are infected even when we don't have symptoms.
- Staying at a distance of at least 1 meter away from each other will prevent the virus from directly contacting one person from another as they speak or cough.
- Regularly washing hands with soap or using hand sanitizer and air disinfectant could eliminate any virus in your hands and in the air, keeping it clean.

## Vaccines for COVID-19

As a viral infection, antibiotics are not an effective treatment. Vaccines are more effective to prevent a severe development of the disease in human body. Since the outbreak, Biotechnology companies are in race to provide vaccines for COVID-19.



## COVID-19 Variants

As the virus spreads world-widely, it replicates rapidly in human's body, causing mutations to occur, modifying their genetics. Scientists call the viruses with these changes "variants". They are still SARS-CoV-2, but may act differently. These changes especially are observed in the way they spread and the severity of the disease.

### Variants of Concern

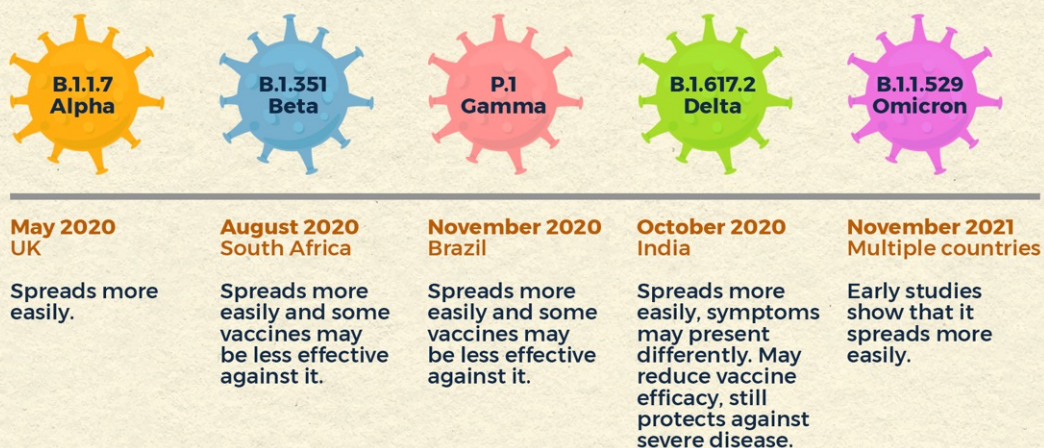


Figure 1.4. COVID-19 Variants of Concern from WHO  
\*Notes: Adapted from Wellcome.org (n.d.) & WHO (n.d.)



## Research and Discussion Topic

To be aware and to understand more about Health and Environmental Issues that happened during the COVID-19 Pandemic, VCHEI Science Club members of Mountainview Secondary Highschool had the chance to do literature studies and discussion activities. Sub-topics are studied and presented individually, followed by group discussion on the weekends. All of the report presented in this book is the result of those individual literature studies and peer discussions of the group. A total of 7 sub-topics about Health and Environmental Issues during the COVID-19 Pandemic were studied and discussed by 7 members of VCHEI Science Club during the second half of 2021/2022 school year in Mountainview Secondary Highschool. Those sub-topics includes:

### **Ju Young Oh**

Club Leader

*How does the vaccine regulation effect the spread and deaths of COVID-19 in South Korea?*

### **Ju Won Park**

Member of the Club

*How does SARS-CoV-2 affect our body and how different is the omicron variant affecting our body compared to the original virus?*

### **Eugenia Trosmada**

Member of the Club

*How does COVID-19 patient's chest-CT result differ from the healthy ones?*

### **Hui Min Mak**

Member of the Club

*How effective are lung transplants for COVID-19 patients?*

### **Hyo Eun Lee (Cris)**

Member of the Club

*What are the medicines uses for COVID-19 patient?*

### **Cherish Andrea**

Member of the Club

*How does supplements help our body fight against COVID-19*

### **Yoon Jin Kim**

Member of the Club

*What are the effects of massive use of mask and sanitation products during the pandemic to the environment?*



# HOW DOES SARS-COV-2 AFFECT OUR BODY AND HOW DIFFERENT IT IS WITH THE OMICRON VARIANT?

– by Juwon Park





## How does SARS-CoV-2 affect our body and how different it is with the omicron variant? – by Juwon Park

### Background

Since its first occurrence in December 2019, the SARS-CoV-2 virus causing the COVID-19, has deal massive casualties and shifts in daily life worldwide. The virus is indeed threatening as it quickly spread throughout the human population. Some of the symptoms includes “coughing, fever, general malaise, dyspnea and respiratory distress, that might eventually lead to death” (Trypsteen, 2020). But a question emerges: how/ why is it dangerous? Since the pandemic, scientists are challenged to find good strategies to contain and treat the virus (Trypsteen, 2020). To do so, it is important to chart the viral presence in human body in order to improve diagnostics, prevention or treatment (Trypsteen, 2020). Scientists are challenged even more as the emergence of COVID-19 variants shows more challenging situation in the effort to contain and treat the virus. For instance, Delta variant is 7 times more contagious and has a higher chance of inflicting severe damage (Unicef, 2021). On the other hand, Omicron, the latest variant of concern that has occur in the pandemic, although less severe than the Delta, is shown to be 5 times more contagious (Unicef, 2022). Let us find out how the COVID-19 virus infiltrates our body and deals harm, also, examine how omicron variant could impose a more challenging situation in dealing with the pandemic.

### SARS-CoV-2 lifecycle and mechanism

The COVID-19 infiltration happens through the respiratory system, meaning that the virus flows into our nose and mouth using the air we breathe in as a medium. Although the virus itself isn't airborne, they can attach themselves to microscopic water droplets called aerosols and stay airborne for up to 30 mins, making it no big deal to move among infected and healthy people. Once the virus arrives at the airways and lungs, this is when the infection really begins. (Mandavilli, 2020).

Cells in our body have parts ‘receptors’ which are used to receive information and commands. The COVID-19 Virus attaches itself specifically to a receptor called ACE2 and enters the cell. Once inside, the virus releases its genetic information, or RNA. The

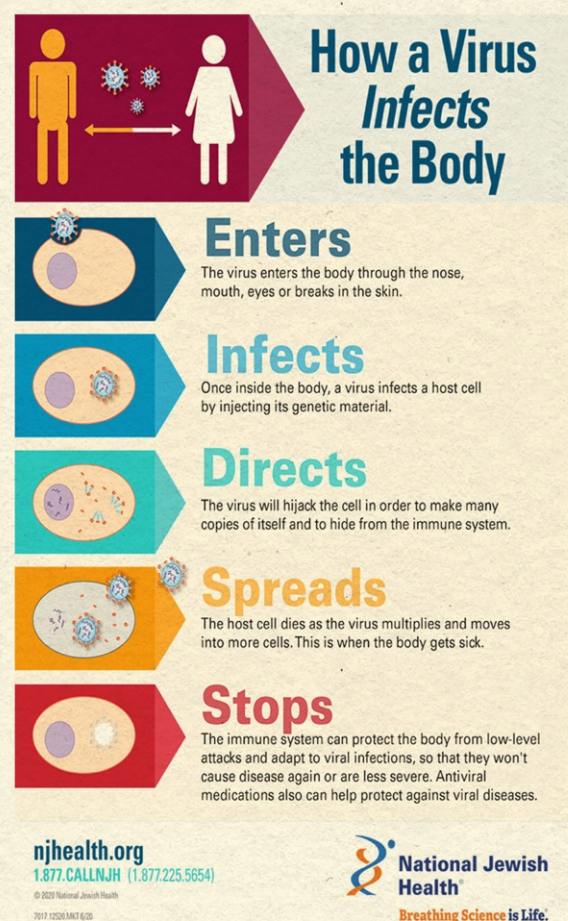


Figure 2.1. Process of virus infiltrating the body  
\*Source: (National Jewish, 2020)



# LIFE CYCLE OF THE PANDEMIC CORONAVIRUS

A simplified account of how SARS-CoV-2 enters and exits cells.

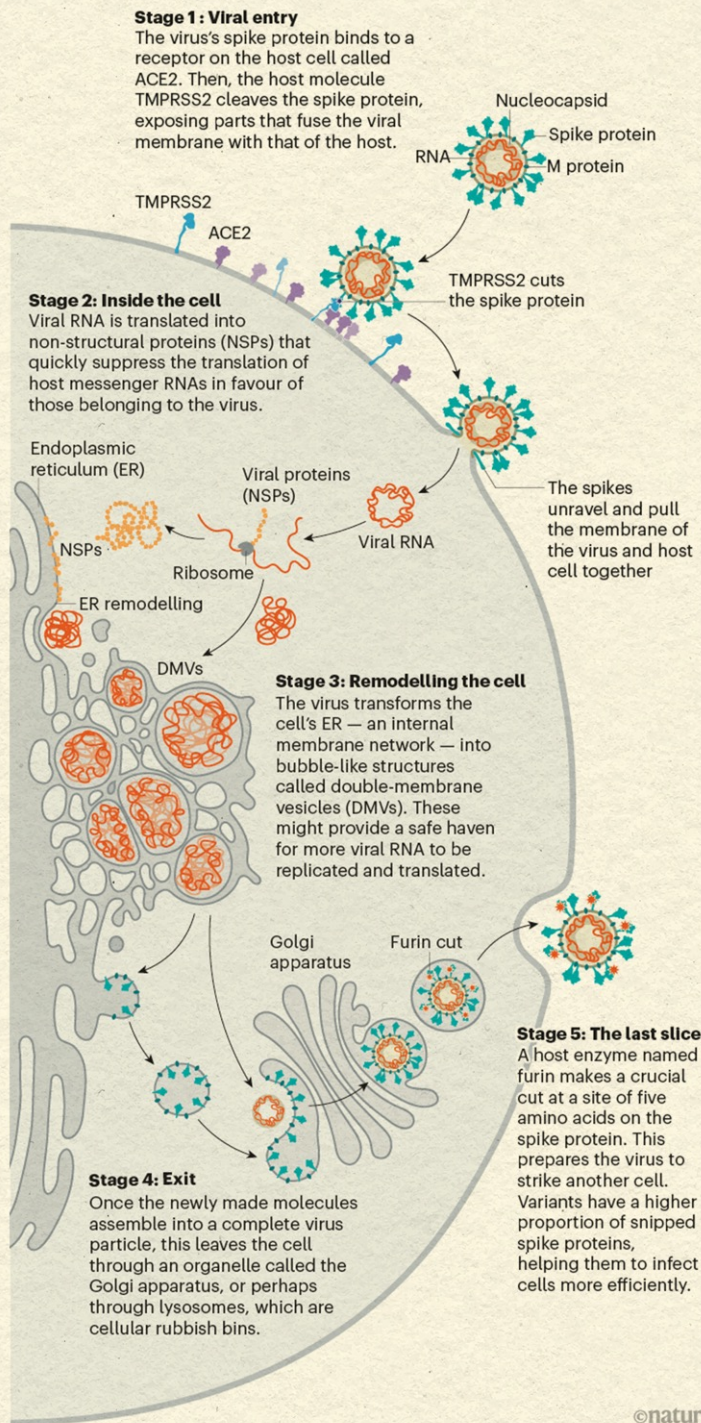


Figure 2.2. SARS-COV-2 lifecycle in human cell  
\*Source: (Scudellari, 2021)

allowing the virus to ejects its genome directly into the cell. With this spring-loaded manner, SARS-CoV-2 is able to infects faster than SARS-CoV, avoiding being trapped in endosomes (Scudellari, 2021).

cell, which the virus had taken over, starts replicating the RNA to produce more viruses. The rapid production of viruses through a cell eventually kills the cell, leaving behind more viruses and debris from the dead cell. This debris causes symptoms such as coughing. (Scripps Research, 2020; Wadman et al., 2020).

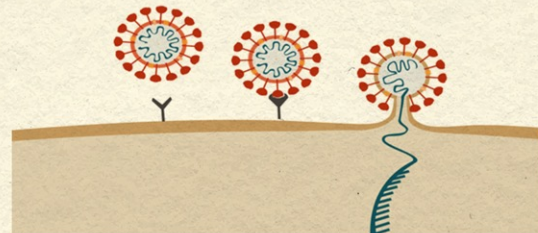


Figure 2.3. How the COVID-19 virus enters a cell and injects its RNA  
\*Source: (LA Times, n.d.)

SARS-CoV-2 differs from SARS-CoV because it efficiently uses TMPRSS2, an enzyme that is highly abundant outside our respiratory cells, to break into our cells. TMPRSS2 will cut a site on the spike's S2 subunit8 from the virus which will expose a chain of hydrophobic amino acids that "rapidly buries itself in the closest membrane" — the host cell. Like a zipper, the extended spike will fold onto itself, bringing the viral and host cell membrane together, fusing,

## VIRAL ENTRY UP CLOSE

Virus and host-cell membranes fuse after the TMPRSS2 enzyme cuts a SARS-CoV-2 spike protein. This exposes hydrophobic amino acids in the spike that rapidly embed themselves into the nearest membrane — that of the host cell.

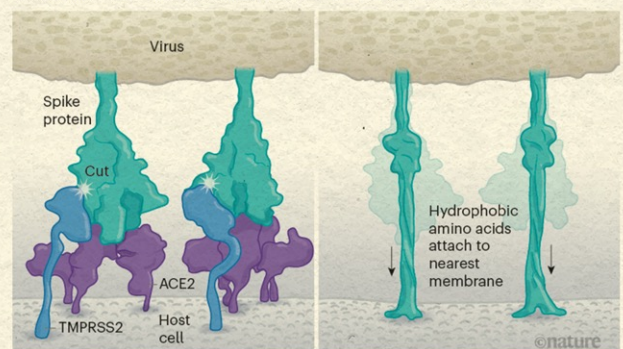


Figure 2.4. SARS-CoV-2 binding mechanism to host cell  
\*Source: (Scudellari, 2021)



## Immune response to SARS-CoV-2 infection

Our body responds to the rapidly growing virus population by activating the immune system, calling white blood cells to fight against the viruses and exterminate them from our body. The battlefield is visible through CT scans due to the fight also disturbing oxygen flow and making the patient hard to breathe. Sometimes the severity of the virus might result in the overreacting of the immune system, named Cytokine storms. In this case, the immune system would also attack healthy cells, worsening the situation (Thirukrishna et al., 2022; Wadman et al., 2020).

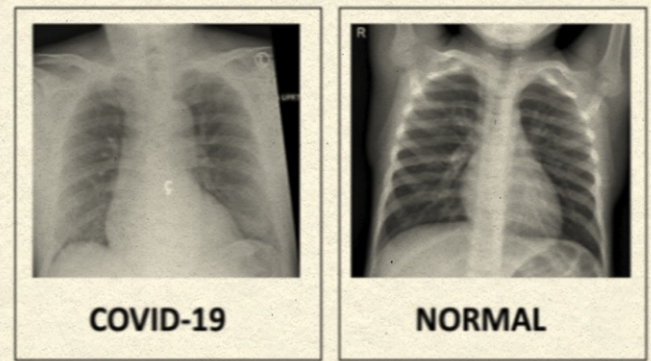


Figure 2.5. X-ray images of COVID-19 patients vs normal  
\*Source: (Thirukrishna et al., 2022)

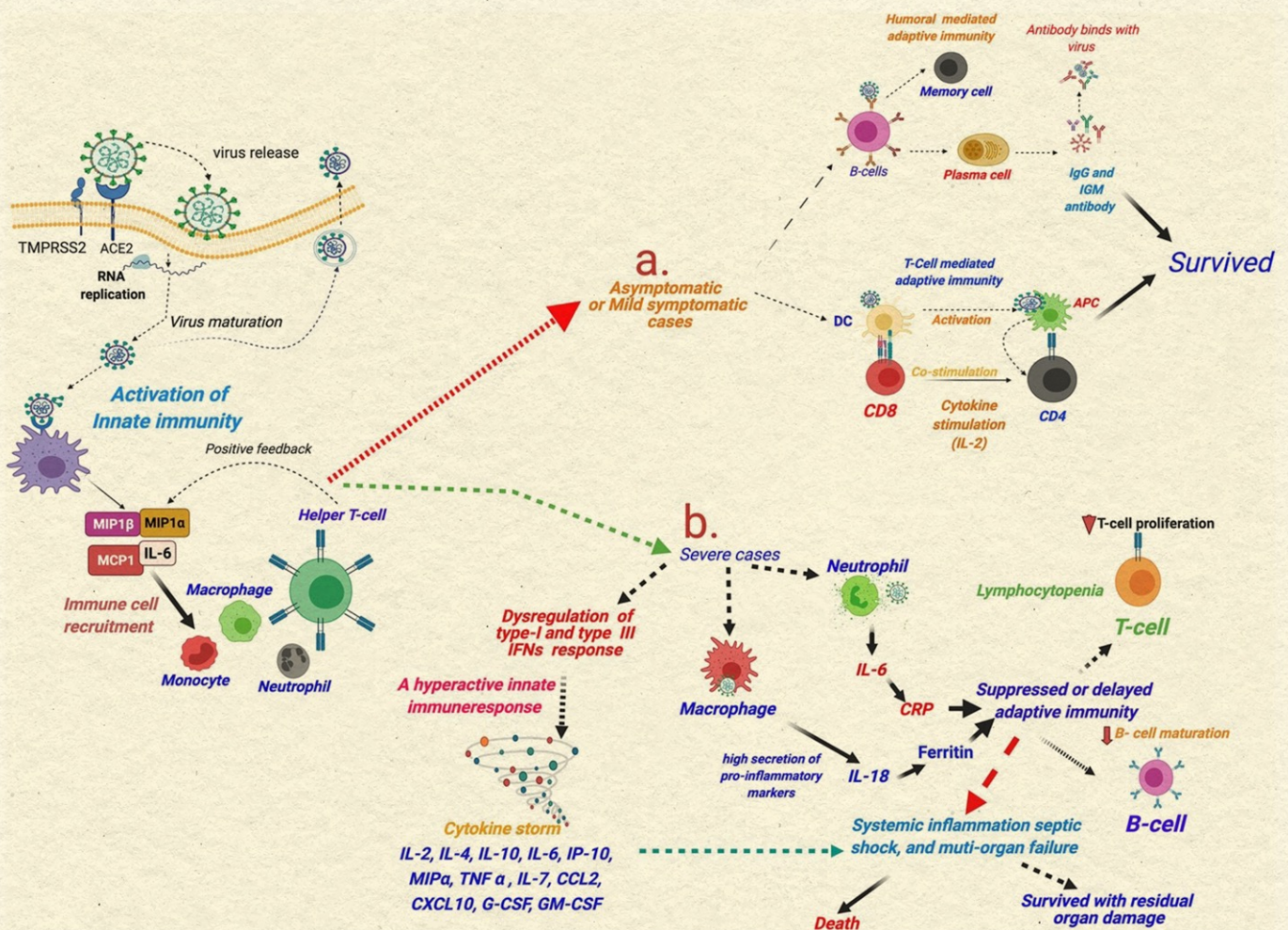


Figure 2.6. Immune response to SARS-CoV-2 infection  
\*Source: (Kumar et al, 2021)



Our immune system reacts to the viral infection in 2 ways. Adaptive immune system will take time to respond to the virus by developing and deploying antibodies to specifically disable the virus, but innate immune system immediately respond to the infection area with a nonspecific responses that may also harm healthy cells along the way. The sooner our body are able to activate the adaptive immune response and make specific antibodies to dismantle the virus, the less damage our body will take from the unspecific response of our innate immune system. Figure 2.6(a) shows that when adaptive immunity is produced sooner, patients will have milder symptoms. But when adaptive immunity is delayed (b), our immune system will attack not only infected cells but also healthy cells, and the damage is worsen even more when cytokine storm occurred, and could even cause death. Pre-existing genetic factors may be the prime reason of vulnerability in certain individuals but little is known about it yet (Kumar et al., 2021).

“Even though the first studies on SARS-CoV-2 tropism and pathogenesis focused on the lungs, as these were “the viral ground zero”, it quickly became clear that SARS-CoV-2 also attacks other organ systems, either by direct viral infection or through indirect effects of the immune response” (Trypsteen et al., 2020). The effects of the COVID-19 virus have been found in areas all around the body, including the heart, kidneys, brain, and the digestive system. Just by looking at the case in Wuhan, up to 20% of the COVID-19 patients had heart damage, and 27% had kidney failure.

## Mutation of SARS-CoV-2 & the omicron variant

WHO Label : Omicron  
Pango Lineage : B.1.1.529

### Genomic Mutation:

The spike protein of the Omicron variant is characterized by at least 30 amino acid substitutions, three small deletions, and one small insertion. Notably, 15 of the 30 amino acid substitutions are in the receptor binding domain (RBD). There are also a number of changes and deletions in other genomic regions.

### Transmissibility:

Analysis of the changes in the spike protein indicate that the Omicron variant is likely to have increased transmission compared to the original SARS-CoV-2 virus, but it is difficult to infer if it is more transmissible than Delta.

### Disease Severity:

Preliminary information from South Africa indicates that there are no unusual symptoms associated with Omicron variant infection, and as with other variants, some patients are asymptomatic.

### Impact on Vaccine-Induced Immunity:

Based on the number of substitutions, the location of these substitutions, and data from other variants, it is anticipated that the protection from infection is reduced.

Source: (CDC, n.d.)



As the SARS-CoV-2 rapidly spread and multiply in human body, it gives more opportunity for mutation to occur. Human immune system intervention introduces viral mutations and although most viral mutations are benign, many mutation results in strengthening the viral survival capability. To predict future infection tendency, it is of paramount importance to understand SARS-CoV-2 infectivity changes following the existing mutations (Chen et al., 2020).

### Important Mutation Sites of Omicron Variant (See Appendix 2.1 for more mutation sites)

<b>N501Y</b>	increases binding to the ACE2 receptor, which could increase transmission, and the combination of N501Y and Q498R may increase binding affinity even more; however, other substitutions in the Omicron spike protein are expected to decrease binding to ACE2.
<b>H655Y</b>	is proximal to the furin cleavage site and may increase spike cleavage, which could aid transmission.
<b>N679K</b>	is proximal to and adds to the polybasic nature of the furin cleavage site, which may also increase spike cleavage and could aid transmission.
<b>P681H</b>	has been shown to enhance spike cleavage, which could aid transmission. This mutation is found in Alpha and an alternate mutation at this position (P681R) is found in Delta.

Source: (CDC, n.d.)

### Final Thoughts

We've examined how the COVID-19 virus enters our body and what damages it causes to it. The virus entered our body through the respiratory system, multiplied itself using the cells, and in the process caused harm to the surrounding cells/tissue by taking control of the cells or through the impact of immune response trying to annihilate the virus but also killing the surrounding healthy cells. Now that we know why the COVID-19 virus is such a worldly concern, especially with the emergence of variants, we understand the importance of avoiding the risk of catching the disease through wearing masks and getting vaccinated.



Appendix 2.1. Omicron variant Spike Protein Mutation

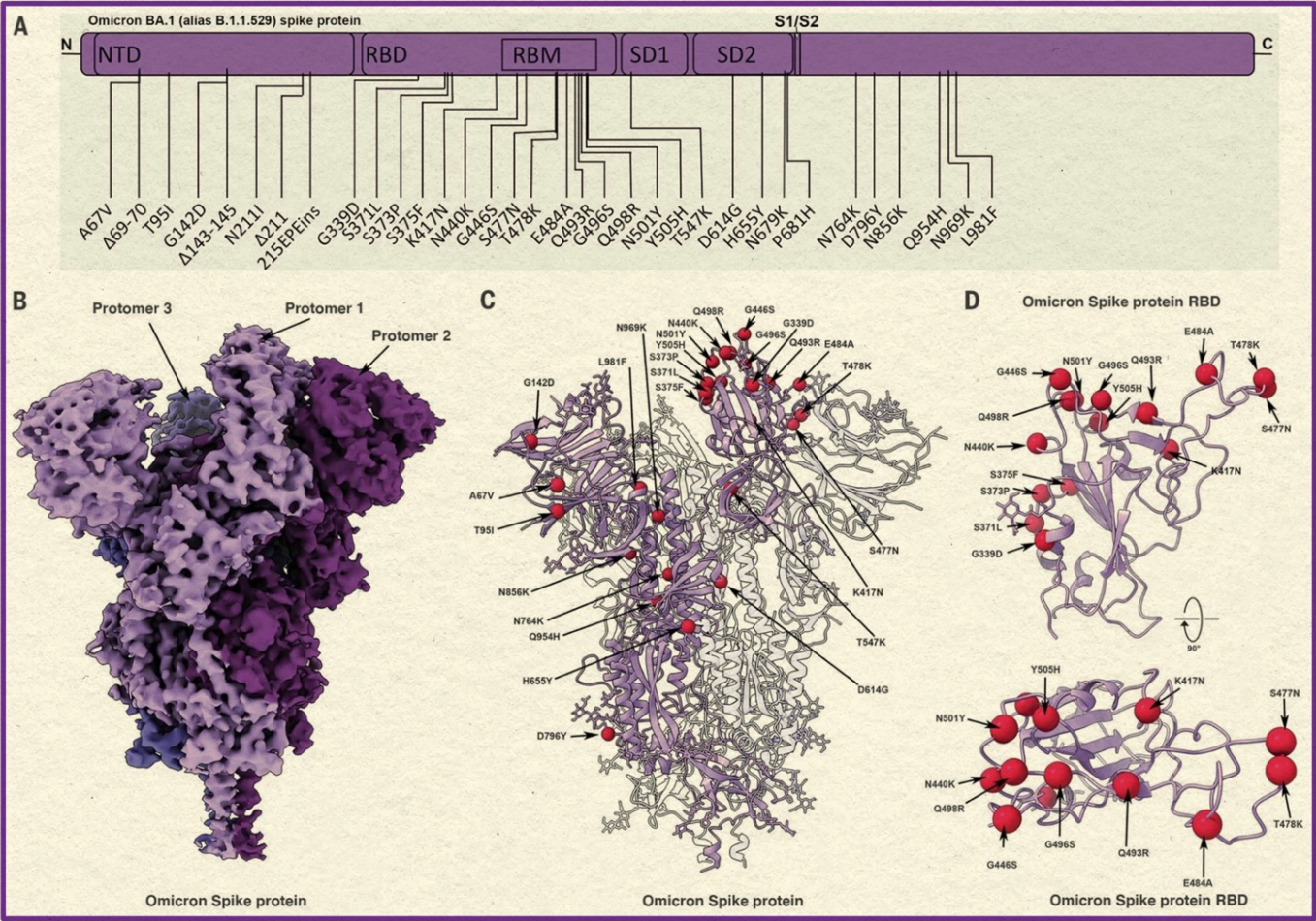


Figure 2.7. Omicron Variant Mutation  
\*Source: (Mannar et al, 2022)



# HOW DOES THE VACCINE REGULATIONS EFFECT THE SPREAD AND DEATHS OF COVID-19 IN SOUTH KOREA?

- by Ju Young Oh





## How does the vaccine regulations effect the spread and deaths of COVID-19 in South Korea? - by Ju Young Oh

### Background



Figure 3.1. Vaccines available in South Korea  
\*Note: a) Pfizer b) AstraZeneca c) Moderna d) Janssen

Due to the emergence of COVID-19 pandemic, many countries have begun the usage of vaccines to deal with the virus. Since COVID-19 is a viral infection, protection is achieved mainly by virus-neutralizing antibodies that are produced when people actually get infected. Instead of getting COVID-19, the usage of vaccines allowed our bodies to be introduced to inactive viruses. These inactive viruses help our bodies to produce antibodies without actually getting infected by the real COVID-19 virus (Speiser & Bachmann, 2020).

In South Korea, people are not required to be vaccinated. However, up until February 2022, people were prohibited from using public facilities without a vaccine pass (QR pass). Despite the overall negative perception of the COVID-19 vaccine, which are caused by the fear of side effects and safety reasons, people still got vaccinated to use the public facilities. The most common types of vaccines people got are Pfizer, AstraZeneca, Moderna, and Janssen (Johnson & Johnson) (Lee et al., 2021). We have conducted a literature study to see how effective vaccine regulation in South Korea is in preventing the cases and deaths of COVID-19 in the country.

### Findings

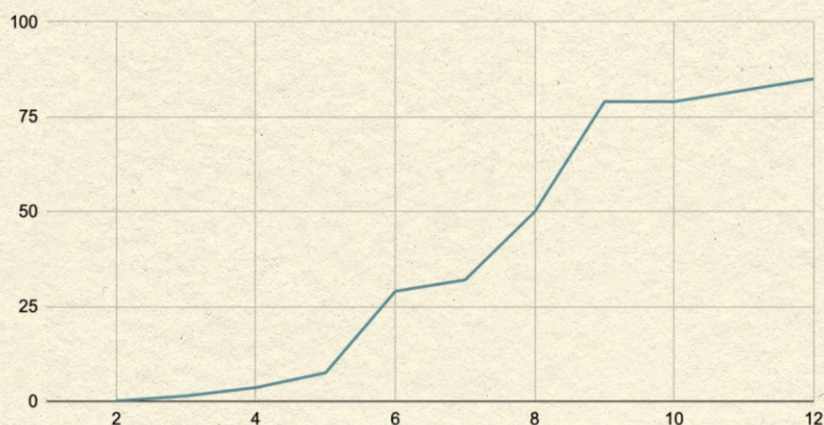
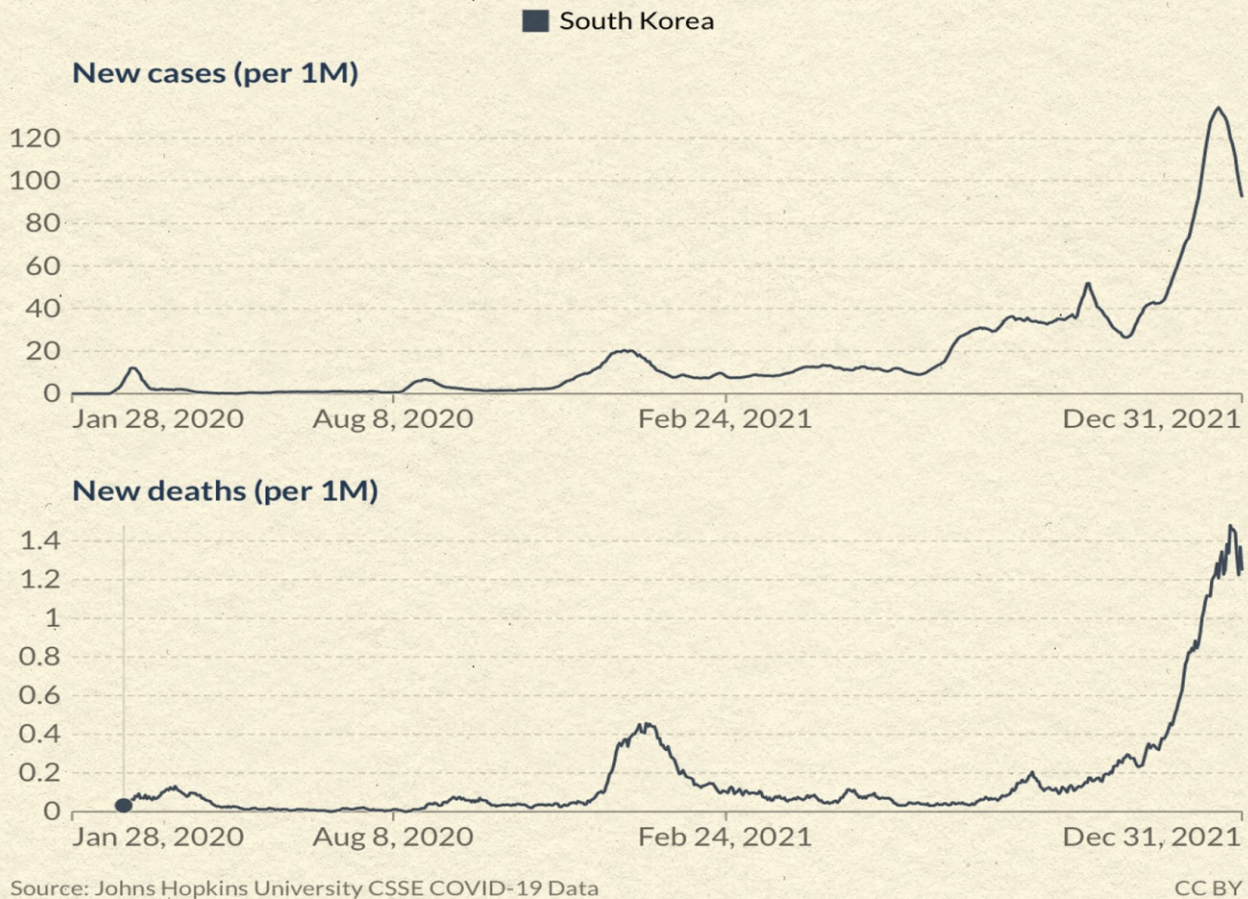


Figure 3.2. Monthly vaccination coverage of the entire population in South Korea (in percentage)  
\*Source: ourworldindata (n.d.a)





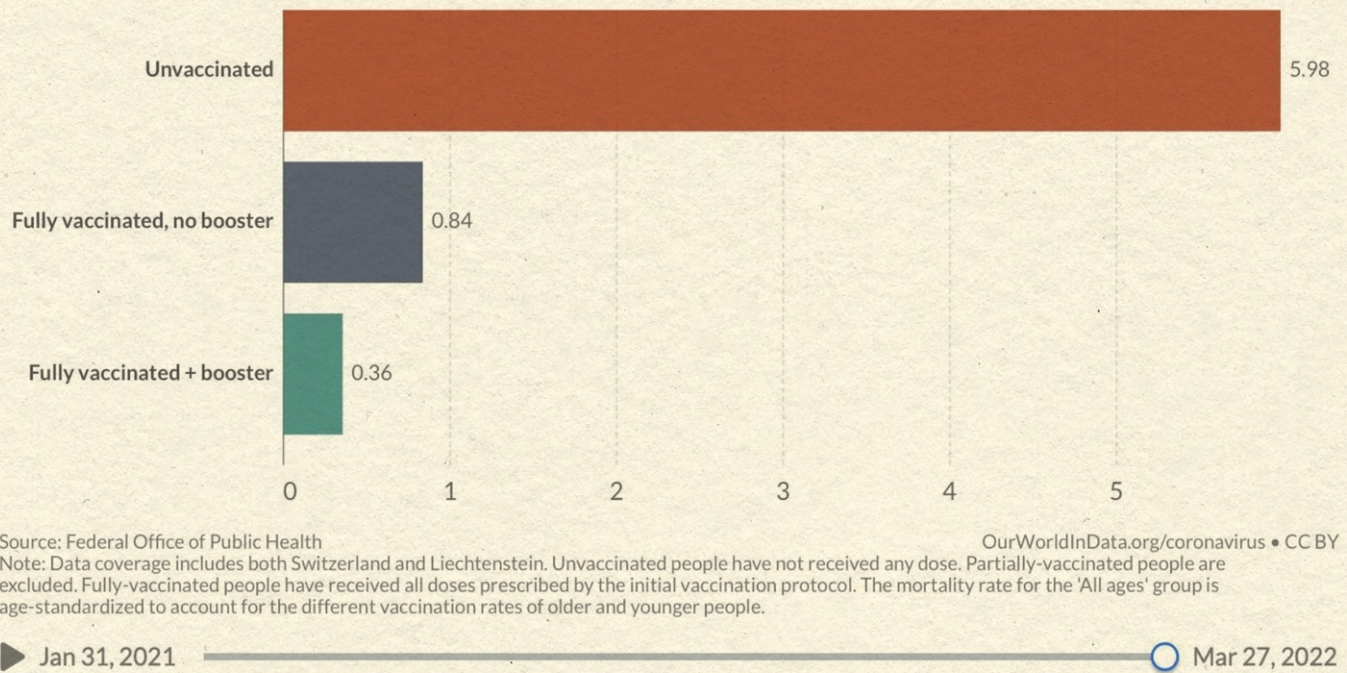
*Figure 3.3. Daily new confirmed COVID-19 cases and deaths per million people*  
*\*Source: ourworldindata (n.d.b)*

## Discussion

The COVID-19 vaccination in South Korea began in February 2021 and as of April 2022, 87.6% of the population got the first dose, 86.7% of the population got the second dose, and 64.2% of the population got the third dose, or the booster shot. During the first year (2021), as the vaccination coverage in South Korea increased (more people are getting vaccinated), the trend of COVID cases generally increased. This is not a weird situation because vaccines work to help our body produce antibodies to neutralize the virus (Speiser & Bachmann, 2020). Vaccines don't always prevent us from getting infected by the virus, but it may help prevent worsening of body condition once they get infected. Even though vaccines may not decrease the number of cases, it should be able to decrease the number of deaths. However, because the data that we used for number of COVID-19 deaths in South Korea doesn't classify the status of being vaccinated (inclusion or exclusion of booster shot) or unvaccinated, it is hard to figure out directly how COVID-19 vaccination in South Korea affects the mortality rate of the disease.

According to Mathieu and Rosser (2021), studies based in Switzerland, America, and Chile showed that people who got COVID-19 and weren't vaccinated had a higher mortality rate than the population of people that were vaccinated (Figure 3.4.). This is good evidence that vaccines could be helpful in reducing the mortality of COVID-19. Without the usage of vaccines, the rise of COVID-19 deaths might have been drastically worse.





**Figure 3.4. COVID-19 weekly death rate by vaccination status (all ages) in Switzerland**  
*\*Note: The same trend is shown in US and Chile (Mathieu & Rosser, 2021)*

Another thing to consider is that the vaccine efficacy varies depending on the virus variants (Falahi & Kenarkoohi, 2021). Since there are changes in the virus' RNA, the vaccine might not work as effectively to fight mutated virus variants. The type of vaccine and the host factors -- age, sex, genetics, immune history (etc.) may also affect vaccine efficacy (Falahi & Kenarkoohi, 2021). Furthermore, there are things that also affect transmission and fatality rate of COVID-19 -- social distancing, geographical location, temperature, humidity, race (Cao et al., 2021), population density, testing rate, traffic, and elders (Roy & Gosh, 2021; Velasco et al., 2021).

## Conclusion

The usage of vaccine pass increased the vaccination coverage in South Korea, but didn't decrease the number of COVID-19 cases and deaths. Instead, due to the emergence of new COVID-19 variants, such as Delta and Omicron, the number of cases and deaths rapidly increased. Despite the steady rise of COVID-19 cases and deaths, the vaccination coverage might greatly contribute to the outcome, where vaccinated people would have lower mortality rates than those who weren't.



# HOW DOES COVID-19 PATIENTS CHEST CT RESULT DIFFER FROM THE HEALTHY ONES?

– by Eugenia Trosmada.





## How does COVID-19 patients chest CT result differ from the healthy ones? – by Eugenia Trosmada

### Background

CT-Scan is a computerized tomography (CT) scan that combines a series of X-ray images taken from different angles around your body and uses computer processing to create cross-sectional images (slices) of the bones, blood arteries, and soft tissues within your body. Since the COVID-19 Pandemic, it has become an important method of diagnosis for COVID-19. Chest CT-scans may be helpful in diagnosing the disease in individuals (Mayo Clinic, 2022). CT Scan could be an important method of diagnosis for COVID-19 pneumonia; especially in individuals with high clinical suspicion of infection. It could also detect acute pulmonary embolism in COVID-19 patients.

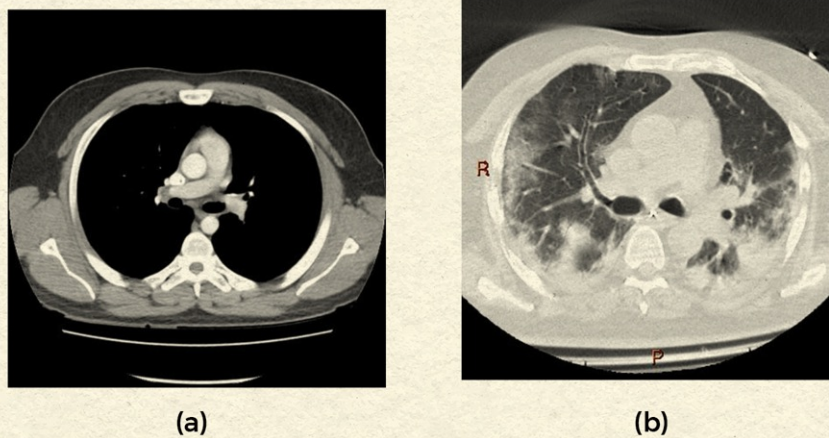


Figure 4.1. CT Thorax Result

\*Notes: (a) Healthy person; (b) COVID-19 patient

\*Source: radiopaedia.org; case courtesy of Dr. Andrew Dixon (a) and Dr. Derek Smith (b)

### Findings

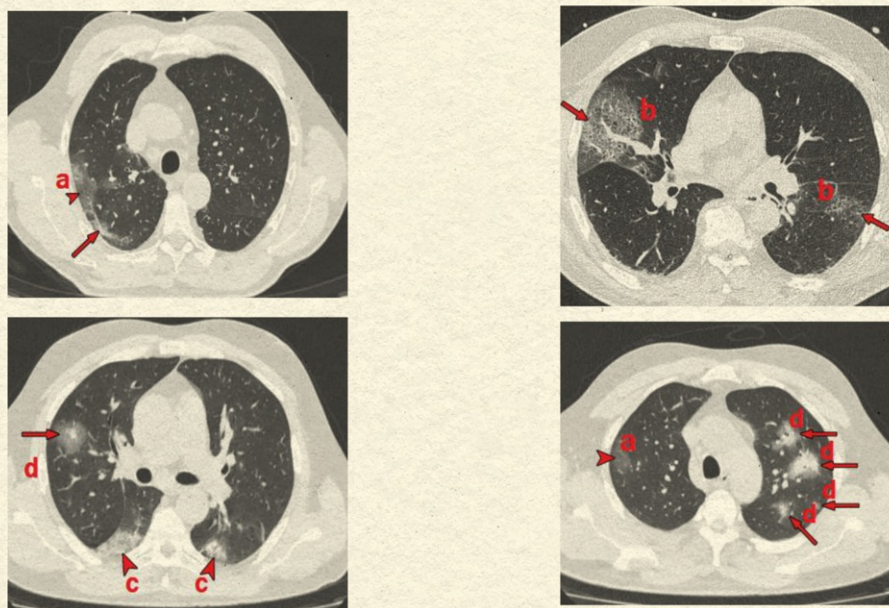


Figure 4.2. CT Thorax Features in Patient with COVID-19

\*Notes: (a) Ground Glass Opacity; (b) Crazy Paving Pattern; (c) Consolidations; (d) Halo Sign  
(Kwee & Kwee, 2020)



## IMAGING

CLASSIFICATION	RATIONALE	CT FEATURES
Typical appearance	Commonly reported imaging features of greater specificity for COVID-19 pneumonia	Peripheral, bilateral, and rounded multifocal ground-glass opacities with or without consolidation or visible intralobular lines ("crazy-paving" pattern) Reverse halo sign or other findings of organizing pneumonia (seen later in the disease).
Indeterminate appearance	Nonspecific imaging features of COVID-19 pneumonia	Absence of typical features AND the presence of the following features: multifocal, diffuse, perihilar, or unilateral ground-glass opacity with or without consolidation lacking a specific distribution and that are non rounded or non peripheral. Few small ground-glass opacities, with a non rounded and non peripheral distribution.
Atypical appearance	Uncommonly or not reported features of COVID-19 pneumonia	Absence of typical or indeterminate features AND the presence of the following features: isolated lobar or segmental consolidation without ground-glass opacities; discrete small nodules (centrilobular, "tree in-bud" appearance); lung cavitation; smooth interlobular septal thickening with pleural effusion.
Negative for pneumonia	No features of pneumonia	No CT features to suggest pneumonia.

*\*Source: "Proposed Reporting Language for CT Findings Related to COVID-19" Table from Radiological society of North America experts consensus document on report chest CT findings related to COVID-19 by Simpson et al. 2020 adapted by Kwee & Kwee, 2020*

## Discussion

The CT findings commonly observed in patients with COVID-19 pneumonia are the expression of acute interstitial (multiple) lung damage, and resulting parenchymal changes caused by immune response such as cytokine storm triggered by the attachment of the virus into the pneumocytes (alveolar cells). Patients with COVID-19 pneumonia may show different disease severity, from mild to critical. For example, in severely ill patients, the most common CT finding is consolidation rather than Ground-glass opacity (GGO) (Pontone, et al., 2020). Normal CT findings are usually shown during the first 4-5 days after symptom onset, but in a non-eligible number of symptomatic cases, normal CT findings are also observed during the later stage of infection. Low viral loads and its confinement to the upper respiratory tract, and also host-factors which lead to the absence of pulmonary inflammatory response caused a false-negative to chest CT findings. Older patients and patients with underlying disease (including diabetes mellitus, cardiovascular disease, respiratory disease, hyperlipidemia, obesity, and chronic kidney and liver disease) may be more susceptible to severe disease.



Thus, showing severe signs in chest CT-findings. Otherwise-healthy children with milder symptoms, may not show any signs of abnormalities in chest CT-findings. The long-term sequelae of COVID-19 are still largely unknown (Kwee & Kwee, 2020).

A meta-analysis, which studies a total of 1431 patients who were mainly symptomatic, reported a chest CT sensitivity of 94.6% in detection of COVID-19. However, another meta-analysis showed that 10.6% of symptomatic patients with positive RT-PCR results, have normal chest CT findings. This suggests that sensitivity may be considerably lower than recorded in the initial study and a negative chest CT result does not exclude COVID-19. Because of this reason, Fleischner Society consensus has not fully decided whether chest CT should be used as a screening tool, either as a stand-alone screening tool or as an adjunct to RT-PCR tests (Kwee & Kwee, 2020).

## **Conclusion**

Typical appearance (>70%) of CT-Scan result in patients with COVID-19 are ground-glass opacities (with or without consolidations or crazy paving pattern) and halo signs, while in normal people, no CT features suggest pneumonia. Even though it could be very different between normal people and patient with COVID-19, there are atypical appearances (<10%) of CT-Scan result in patients with COVID-19 that do not show the signs/features of COVID-19 pneumonia and are more similar to a normal chest CT result. This is usually shown in asymptomatic patients.



# HOW EFFECTIVE ARE LUNG TRANSPLANTS FOR COVID-19 PATIENTS?

– by Hui Min Mak





## How effective are lung transplants for covid-19 patients?

– by Hui Min Mak

### Background

Table 5.1. Participating Healthcare Centre

No.	Healthcare Centres	State/City, Country	Recipients
1	Northwestern Medicine Lung Transplant Program, Northwestern University	Chicago, IL, USA	4
2	University of Florida Health	Gainesville, FL, USA	3
3	University of Milan	Milan, Italy	2
4	Lung Transplant Program of the Medical University of Vienna	Vienna, Austria	1
5	Norton Thoracic Institute	Phoenix, AZ, USA	1
6	MGM Healthcare	Chennai, India	1

Many COVID-19 patients develop irreversible lung damage. In severe cases, patients rely on invasive mechanical ventilation and ECMO (venous-venous extracorporeal membrane oxygenation) without improvement (King et al., 2022).

To combat these problems, medical workers have started relying on lung transplants, which provide patients the possibility to improve their lung condition and not be attached to machines. Usually, lung transplants are performed on those with COPD (chronic obstructive pulmonary disease), pulmonary fibrosis, pulmonary hypertension, or cystic fibrosis (Mayo Clinic, 2022). It is now also considered for COVID-19 patients with ARDS (acute respiratory distress syndrome) and pneumonia (Bharat et al., 2021).

We conducted a literature study to evaluate the effectiveness of lung transplants to address irreversible lung damage problems in COVID-19 patients. To answer the question, we present a study done by Bharat et al. (2021) using data from 6 international centers (Table 5.1). Patients involved in this study went under bilateral lung transplantation.

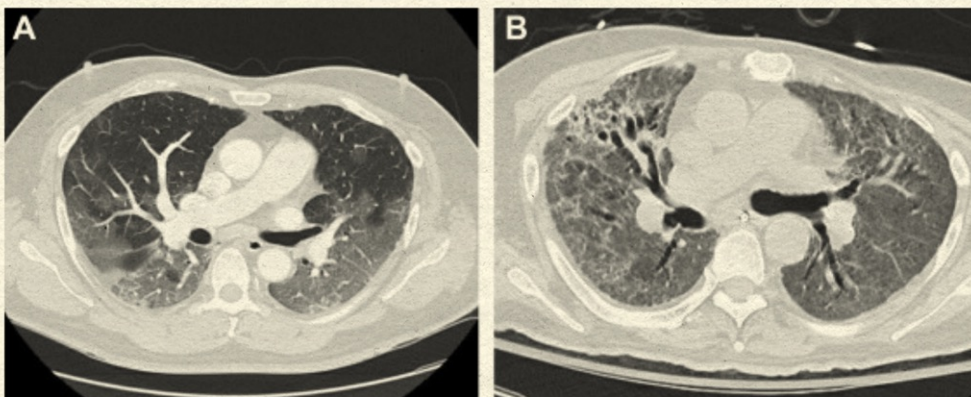
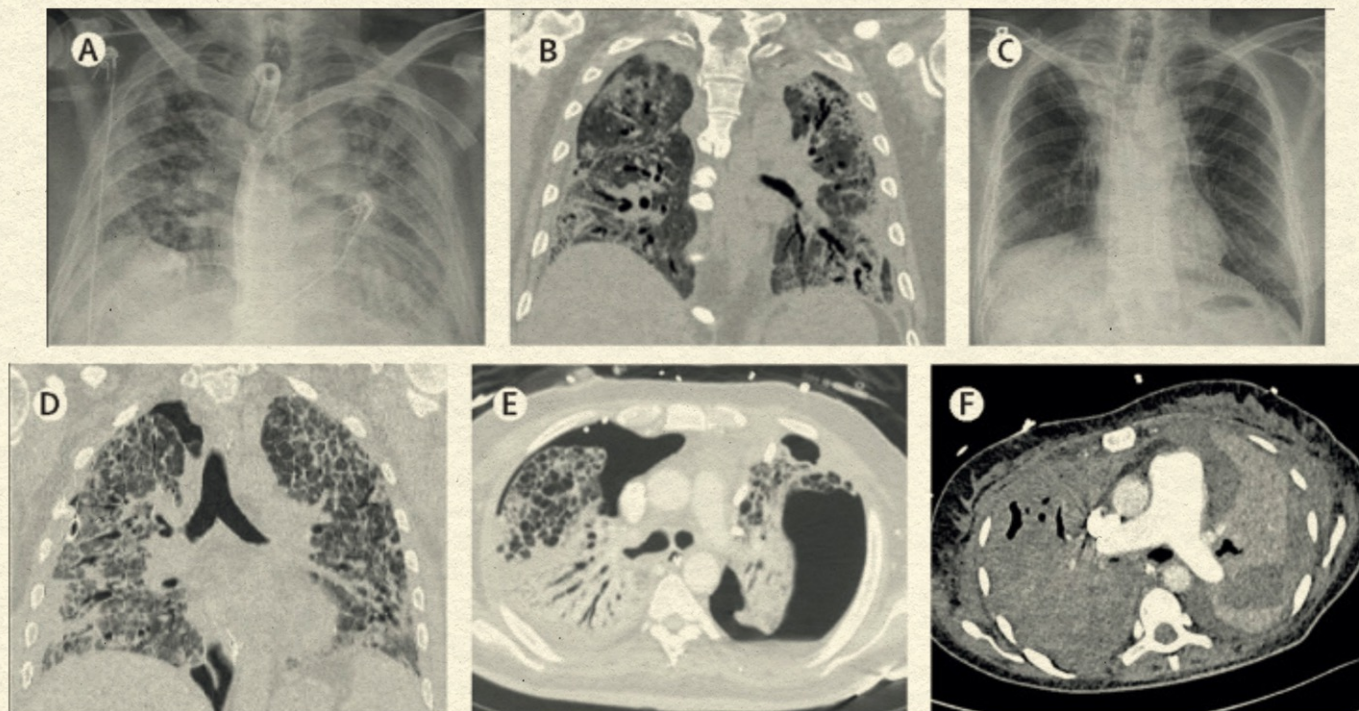


Figure 5.1. Lung damage progression caused by COVID-19  
\*Description: A) Lung when admitted B) Lung 5 months after admission  
\*Source: (Bharat et al, 2021)

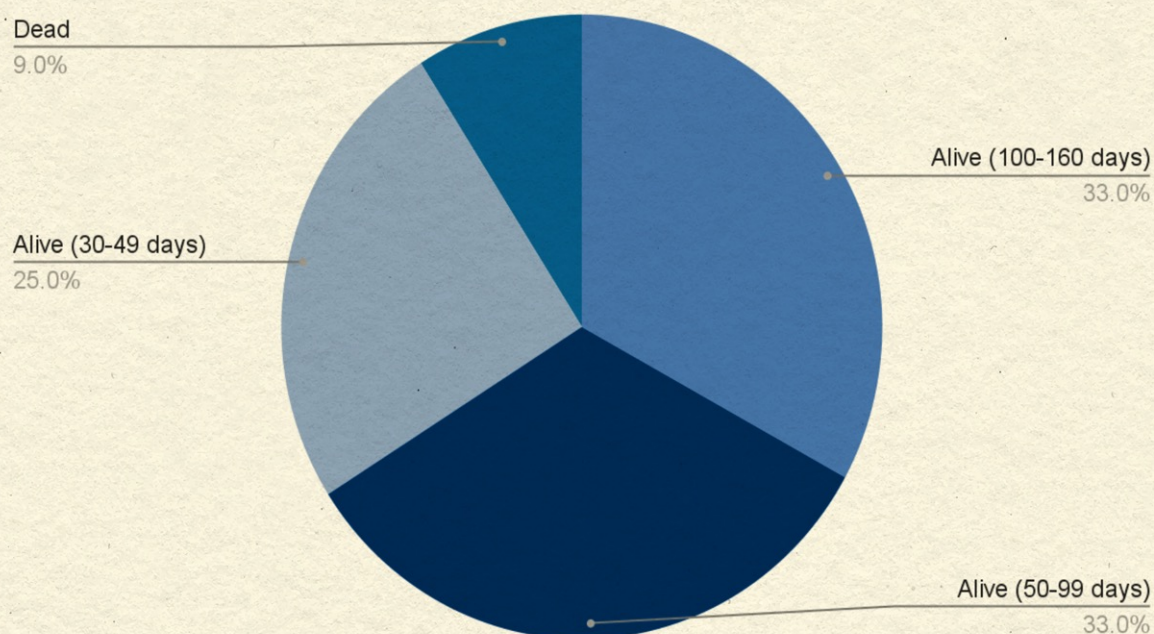
Among 12 recipients, 11 used whole lungs, while one required lobar transplantation. This was caused by the severe contraction of the pleural cavity. Some images of irreversible transplant procedure are shown in Figure 5.1 & Figure 5.2





**Figure 5.2. Lung imaging showing damaged lungs of transplant recipients**  
**Description:** A-B: signs of honeycombing, consolidation, and bronchiectasis; D: fibrosis in all lobes;  
 E: pneumothoraces and shrinking lungs; F: parenchymal necrosis.  
 \*Source: Bharat et al, 2021

## Findings



**Figure 5.3. Data of patients alive or dead after a certain number of follow up days**

**Table 5.2. Lung Transplant Recipients Data**

Patient	1	2	3	4	5	6	7	8	9	10	11	12
Age	44	18	28	48	62	51	48	52	43	34	66	51
Days in ICU after LTx	63	24	31	61	15	10	10	4	24	21	15	19
Days in hospital after LTx	108	42	28	61	38	14	26	11	42	37	still admitted	28
Follow up days	160	160	143	61	112	93	90	70	63	46	33	32
Alive/dead	Alive	Alive	Alive	Dead	Alive	Alive	Alive	Alive	Alive	Alive	Alive	Alive



## Discussion

According to the United Network for Organ Sharing (UNOS), the organ coordinator in the United States, ARDS (acute respiratory distress syndrome) and pneumonia are indicators of whether a patient is eligible to be an organ recipient or not (Bharat et al., 2021). Other than that, another criterion that medical workers look for when determining who is eligible to receive an organ is the severity of their illness and whether or not they would be able to recover without a lung transplant. When people with all these criteria are not treated with a lung transplant, care is usually withdrawn, ultimately leading to death. But the study suggests that lung transplants should be considered at least 4-6 weeks after the ARDS onset; if done too early, the likelihood of spontaneous recovery may be reduced (Bharat et al., 2021).

As shown in Figure 5.3, lung transplantation in the study cohort has shown positive early-post transplantation outcomes, with only one death after a certain amount of follow-up days. Table 5.2 also shows that all recipients were alive for at least 30 days after transplantation, and at least 10 were able to eventually be weaned off mechanical support and return home. However, as stated in the report, even though the early post-transplantation outcomes in the study cohort are found to be positive, the medical complexity of these transplants or the need for substantial resources should not be underestimated. Unlike lung transplantation recipients for chronic lung diseases, all these COVID-19 transplant recipients required longer stays in the ICU and intensive rehabilitation after their discharge. Findings from the study support the importance of considering relatively young and healthy patients as baselines, since they are more likely to tolerate post-transplantation rehabilitation safely. It is believed that the lung transplantation decision making should be done by a multidisciplinary team, which in this case, the centre included: pulmonary and infectious disease specialists, critical care physicians, and surgeons. (Bharat et al., 2021).

## Conclusion

The study suggests that lung transplantation has a therapeutic role in the well-being of patients with COVID-19-associated ARDS who are attached to mechanical ventilation or ECMO, but there is a long list of considerations to be made by medical workers, in order to eventually decide on proceeding with lung transplantation procedure for selected patients.



# WHAT ARE THE MEDICINES USES FOR COVID-19 PATIENTS?

– by Cris Lee






## What are the medicines uses for COVID-19 patients? – by Cris Lee

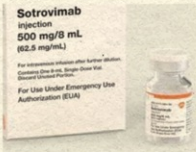

### Background

COVID-19, a disease that affects the respiratory system, has posed a great threat to most people's health ever since 2020. Symptoms of COVID-19 include "fever or chills, cough, shortness of breath or difficulty in breathing, fatigue, muscle or body aches, headache, loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, and diarrhea" (Centers for Disease Control and Prevention [CDC], 2022). The severity of the symptoms varies in people, and in extreme cases, it has led to deaths. However, since COVID-19 is a viral infection, there are no proven effective therapies that target this specific virus (Sanders, et.al., 2020). This is the reason why scientists are working hard to develop medicines or research pre-existing drugs to treat COVID-19 patients. As of today, drug repurposing has been an effective approach in discovering treatments for COVID-19 based on the drug's potential to negate the virus or reduce lung inflammation (Indari et. al., 2021). Before the drug is approved to be used in COVID-19 patients, it needs to go through a substantial amount of clinical trials to evaluate its effectiveness and safety (Indari et. al., 2021). This literature study will give you a summary of some clinical findings about drugs that were used in treating COVID-19 patients.

### Findings

GROUP/ FUNCTION	NAME OF MEDICINE	FINDINGS
<div>ANTIVIRAL MEDICATION</div> 	<b>Found to be Effective</b>	
	Paxlovid	Lowered the risk of hospitalization or death from COVID-19 by 90%; should be taken within 5 days of COVID-19 symptoms
	Remdesivir	Lowered the risk of hospitalization or death by 87%; FDA approved; available for younger kids
	Ensovibep	Lower risk of hospitalization or death from COVID-19 by 80%; work against Delta and Omicron variant
	<b>May be effective</b>	
	Molnupiravir	Lowered the risk of hospitalization or death from COVID-19 by 30%; works against Omicron variant; needs to be used within 5 days of COVID-19 symptoms; for those who are at high risk of severe illness
	Sabizabulin	More studies are being conducted, but so far, showed that it can lower risk of death by 55% in people who are hospitalized with moderate to severe COVID-19
	S-217622	Showed promising results in a small clinical trial
	Favipiravir	Some small studies showed that it can clear virus from airway, but clinical trials proved otherwise and also showed that it did not speed up recovery from Covid-19
	Recombinant ACE-2	Shown promising results against COVID-19 in experiments on cells and animals; being tested in large-scale trials



	<b>Found to be ineffective</b>	
	Ivermectin	Clinical trials showed no evidence of benefits; researchers have used a dosage high for humans; WHO did not approve
	Oleandrin	No evidence that it is safe and effective for Covid-19; FDA did not approve
	Lopinavir & ritonavir	Found that it stop coronavirus from replicating but clinical trials proved otherwise; N.I.H recommend against using lopinavir and ritonavir
	Hydroxychloroquine and chloroquine	Experiments on animals showed no benefits in recovering from Covid-19 or preventing from getting Covid-19; FDA warns about potential serious side effects to heart and other organs when used to treat Covid-19
<b>MONOCLONAL ANTIBODIES</b> 	<b>Effective</b>	
	Sotrovimab	Lowered risk of hospitalization or death by 85%
	<b>May be effective</b>	
	Bebteloviman	Expected to work against Omicron
	Tocilizumab	Showed that it lowered the risk of death due to COVID-19; recommended for severe COVID-19 patients
	Leronlimab	Studies shown that it may calm 'cytokine storm' in critically ill and hospitalized patients in New York
	Lenzilumab	Studies have shown that it reduce the excessive inflammatory response from COVID-19
	<b>Not Effective</b>	
	Bamlanivimab & estesevimab	Does not work against Omicron variant
	REGEN-COV (Casirivimab & Imdevimab)	New studies have shown that it does not work against the Omicron variant
<b>CORTICOSTEROID</b> 	<b>Effective</b>	
	Dexamethasone	Reduced 28-day mortality in hospitalized COVID-19 patients who were receiving respiratory support; saved a million lives worldwide based on March 2021 analysis by the British government
<b>INTERFERONS</b>	<b>May be effective</b>	
	Lambda (Pegylated Interferon Lambda-la)	Clinical trials showed promising results; reduced risk of death by 60% when taken within 3 days of Covid-19 symptoms
	SNG001	Still doing clinical trials, but have showed that it lowered risk of severe Covid-19 in patients
	<b>Not effective</b>	
	Rebif	Performed poorly in clinical trials; resulted in worse outcomes for some patients



CONVALESCENT PLASMA	May be effective	Some studies showed that it lowered deaths from COVID-19; target towards patients with an active infection from COVID-19
STEM CELLS	Ineffective	Could potentially harm patients and did not show clear clinical benefit in patients using ventilators

Source: Puckey (2022); Zimmer et al. (2022); Murdock (2022)

## Discussion

As you can see, there are many different drugs used for COVID-19 patients and depending on their conditions, their treatment options can vary. However, most of the drugs mentioned above are used for patients with severe symptoms. People with no or mild symptoms are recommended to take ibuprofen, which is an anti-inflammatory drug, or acetaminophen, which is an analgesic and antipyretic drug that relieves fever and body aches (Harvard Medical School, 2022).

Antiviral medications that are used to treat COVID-19 have the ability to limit the virus' propagation in host cells, but they don't actually kill the virus (Auwaerter & Casadevall, 2022). Nevertheless, the antiviral medications can reduce the illness duration and lessen complications in some people (Auwaerter & Casadevall, 2022). Monoclonal antibodies are man-made antibodies (Harvard Medical School, 2022). Antibodies are an important part of our immune system that the body naturally makes to fight off invaders that have entered the body (Harvard Medical School, 2022).

There is also a type of steroid drug called Dexamethasone used in COVID-19 patients (Auwaerter & Casadevall, 2022). Dexamethasone is known for treating inflammation from asthma, Crohn's disease, and certain cancers (Auwaerter & Casadevall, 2022). In those case, Dexamethasone is used as an anti-inflammatory drug to relieve the inflammation that is caused by hyperactivity or autoimmune abnormality from the immune system. Steroids are important in treating Covid-19 because the disease can cause a "cytokine storm" in some patients (National Institutes of Health [NIH], n.d.). A "cytokine storm" happens when the immune system is overreactive and releases "excessive amounts of proteins that trigger inflammation" (NIH, n.d.). This can result in "life-threatening complications such as acute respiratory disease syndrome and multiple organ failure" (NIH, n.d.). A "cytokine storm" happens due to the fact that when our immune system is hyperactive, it cannot tell the difference between the healthy cells and foreign invaders, so it starts attacking our healthy cells (Cleveland Clinic, 2016).

Lastly, there is a convalescent blood plasma therapy, which involves taking the blood plasma of a recovered COVID-19 patient and injecting it to the patient's body (Mayo Clinic, 2021). When a person recovers from an illness (convalescence), they successfully produce antibodies so that their immune system can fight off the virus, and their antibodies can be used to treat or help someone who is having a hard time fighting off the same virus (Auwaerter & Casadevall, 2022). This therapy is normally recommended for people with weak immune systems (Mayo Clinic, 2021). In August 2020, the FDA granted an EUA (Emergency Use Authorization) for plasma antibodies, which means that it is likely to be beneficial and safe for patients. However, based



on its efficacy and complexity, the FDA then updated its EUA in December 2021 to permit its usage in outpatients and “limited its scope to use in immunosuppressive patients and those on immunosuppressive therapies” (Auwaerter & Casadevall, 2022).

It is important to note that most of the drugs used to combat COVID-19 in patients do not actually kill the virus, but instead it either limit the virus from replicating or reduces the severity of the symptoms by suppressing hyperactivity of our immune system, or by supporting weak immune systems. With that being said, drugs can help people to suffer less while they are sick. Scientists are still working hard to find more drugs that are effective for Covid-19.

## **Conclusion**

The drugs used in COVID-19 patients are helpful in interfering with the mechanism that the virus uses to infect the body. It also supports the immune system, and reduces the pain from fever and excessive inflammation to the lungs caused by the immune response to the virus. The drugs for COVID-19 help in treating the symptoms, but they do not directly kill the virus. Moreover, scientists are still in the progress of developing and finding effective drugs to annihilate SARS-CoV-2 infecting the human body.



# HOW DO SUPPLEMENTS HELP OUR BODY FIGHT AGAINST COVID-19?

– by Cherish Andreea.



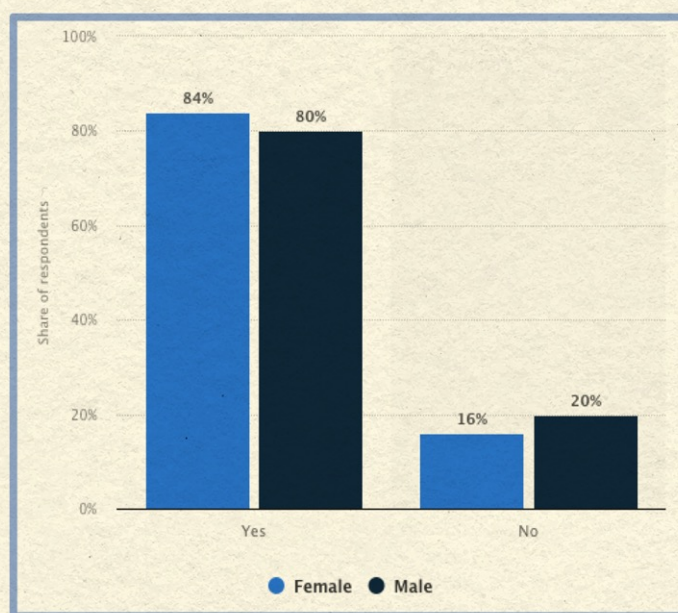


## How do supplements help our body fight against COVID-19?

– by Cherish Andreea

### Background

Supplements are orally-administered products containing at least one of these ingredients: vitamin, mineral, herb, amino acid, or enzyme (NIH, 2020). In general, supplements are consumed as an alternative to obtain missing nutrition when people are sick or unable to obtain specific nutrients from food, in order to improve and maintain general health (Hasan et al, 2020). Due to the positive benefits supplements have on someone's health, the market on these products have drastically escalated during COVID-19. Supplements are not marketed as a treatment, prevention, or cure for any disease, since only medicines can legally make such claims. Sales of supplements increased since the outbreak of COVID-19 as it is marketed for immune health, with the expectation that it would provide protection from the infection of SARS-CoV-2, or help reduce the severity of the disease (NIH, 2022). Some nutrients like probiotics help maintain beneficial microorganisms in our intestines to break down fibers into short chain fatty acids that stimulate the activity of immune cells (HSPH, n.d.). Some vitamins like vitamin D and C, and minerals like zinc are known to modulate immune responses and have anti-inflammatory properties (NIH, 2020). An online survey in Indonesia taken during the COVID-19 pandemic by 4,208 respondents in the age of 16, or older, showed that the consumption of supplements had increased (Nurhayati-Wolff, 2020).



*Figure 7.1. Survey result on the increased supplement intake in Indonesia from July 9-31, 2020*  
*\*Note: The survey question was: "Has your frequency of taking dietary supplements increased after the outbreak of COVID-19?" (Nurhayati-Wolff, 2020)*

### Effects of Supplements on COVID-19

Some of the most common supplements known to be effective in boosting immunity are vitamin D, vitamin C, and zinc; thus, the majority of people have bought supplements consisting of those ingredients during this pandemic. Despite the current perception on supplements in improving immunity, available data so far are still considered to be insufficient to support or oppose the use of any vitamin, mineral, herb, botanical, fatty acid, or other kinds of supplements as a prevention or treatment for COVID-19 (NIH, 2022);




there has been ample misinformation circulating amongst the public concerning supplements in combating the virus (Speakman et al. 2021). It is important to address the role of supplements in this pandemic since many supplements are readily accessible to the general public without medical oversight. Table 7.1. provides a summarization of some studies that analyze completed and published clinical trials regarding some of the most common used supplements for COVID-19.

**Table 7.1. Clinical Findings on The Effects of Supplement Intake in COVID-19 Patients**

<p><b>Vitamin D</b></p> 	<p><b>Known health benefits:</b></p> <p>Vitamin D strengthens our body's immune system (innate/adaptive) from any bacterial or viral illnesses and decreases one's susceptibility in getting asthma and acute respiratory infection.</p> <p><b>Sources:</b></p> <p>Vitamin D is mainly biosynthesized by the body from the exposure to ultraviolet light (UVB) from the Sun; it could also be obtained through foods.</p>	<p><b>Findings:</b></p> <ul style="list-style-type: none"> <li>- Vitamin D has decreased the rate of patients to get admitted into the intensive care unit (ICU).</li> <li>- Patients receiving high-doses of vitamin D were mostly tested negative for SARS-CoV-2 prior to the third week after getting infected.</li> <li>- Based on a study, vitamin D has reduced the mortality risks of COVID-19.</li> <li>- People with vitamin D deficiency have a higher risk of getting infected by SARS-CoV-2.</li> <li>- People with vitamin D deficiency are commonly people who are older, have obesity, and have high blood pressure; these people are often people who receive more severe symptoms of COVID-19.</li> <li>- Countries that have greater mortality rates due to COVID-19 are countries with the most people with vitamin D deficiency.</li> </ul>
<p><b>Vitamin C</b></p> 	<p><b>Known health benefits:</b></p> <p>Vitamin C is an antioxidant that fights free radicals that may damage cells. It also helps limit inflammation and tissue damage associated with immune responses. It has been proven to have a positive performance in fighting against the Epstein-Barr virus, enterovirus/rhinovirus-induced acute respiratory distress syndrome, severe sepsis, and in mechanically ventilated patients with acute respiratory distress syndrome in the ICU.</p>	<p><b>Findings:</b></p> <ul style="list-style-type: none"> <li>- Many studies show different results on the effects of vitamin C on mortality rates and the length of ICU stays of COVID-19 patients.</li> <li>- According to one study, the intake of vitamin C, followed with zinc, did not have any effects on the mortality rates of COVID-19 patients.</li> <li>- Based on another study, COVID-19 patients that consumed high doses of vitamin C stayed longer in the hospital; however, the length of ICU stay and mortality rate were not affected.</li> <li>- A separate study also discovered that COVID-19 patients who were on</li> </ul>



	<p><b>Sources:</b></p> <p>Vitamin C is found in many fruits and vegetables: citrus fruits, tomatoes, potatoes, red and green peppers, kiwifruit, broccoli, strawberries, brussels sprouts, and cantaloupe.</p>	<p>mechanical ventilation and consumed vitamin C supplements had lower mortality rates.</p>
<p><b>Zinc</b></p> 	<p><b>Known health benefits:</b></p> <p>Zinc is a mineral with antiviral and anti-inflammatory properties and helps maintain the integrity of tissue barriers. It also helps the body's immune response and metabolism to work, and plays a role in healing wounds and having the sense of taste and smell. Evidence shows that zinc may reduce the duration of common cold.</p> <p><b>Sources:</b></p> <p>Zinc is found in oysters, crab, lobster, beef, pork, poultry, beans, nuts, whole grains, and dairy products.</p>	<p><b>Findings:</b></p> <ul style="list-style-type: none"> <li>- Based on a study made on COVID-19 patients that were admitted to a hospital in Spain, patients who were zinc deficient with zinc levels lower than 50 mcg/dL had worse symptoms, a longer recovery, and had higher mortality rates.</li> </ul>

*\*Sources: DeSoto, 2022; Speakman et al., 2020; NIH, 2020; Marshall, 2021; Macmillan, 2020; Mayo Clinic, 2020*

Vitamin C, vitamin D, and zinc are required for proper immune function; a person's susceptibility to infections could increase when they lack any of these nutrients (NIH, 2022). Other supplements like botanicals and probiotics are not essential, but might affect immune function. However, measuring the impact of these supplements on immune system is challenging since the immune system is a complex network of organs, tissues, and cells (NIH, 2022). It is also important to follow the recommended dose for supplement intake as side effects may occur and even have adverse effects when supplements are consumed at high doses (NIH, 2020).

## Conclusion

Supplements help boost immunity in response to COVID-19 by providing our body with nutrients and microorganisms that are essential to modulate immune response. Although vitamins, minerals, and other micronutrients derived from supplements do not particularly treat COVID-19 or directly prevent someone from getting infected by this virus, consuming supplements in the recommended amount is beneficial and effective for our body's general immune system to counteract the virus' attack since gaining nutrients only from foods may not be sufficient. Therefore, instead of supplements being a direct tool that fights against COVID-19, supplements help our body's immune system work effectively in dealing with the virus's negative impact on our body and reduces the vulnerability from being infected.



# WHAT ARE THE EFFECTS OF THE MASSIVE USE OF MASKS AND SANITATION PRODUCTS DURING THE COVID-19 PANDEMIC ON THE ENVIRONMENT?

– by Yoon Jin Kim.





## What are the effects of the massive use of masks and sanitation products during the COVID-19 pandemic on the environment?

– by Yoon Jin Kim

### The Use of Mask and Sanitation Products during COVID-19 Pandemic

When COVID-19 emerged from Wuhan, China, to the world, the impact is not only affecting human's health but it also significantly affects country's economy around the world and everyday routine of human life (Selvaranjan et al, 2021). The use of masks and sanitation products increased dramatically as more people wanted to suppress the transmission of the virus and stay healthy. A staggering amount of waste from the pandemic has resulted in about 5,160 to 6,880 tons, including originally dumped wastes, in the ocean (Malin, 2021). A literature Study by Sangkham (2020) estimated the use of mask and medical waste produced in Asia during the pandemic (Table 8.1).

Table 8.1 Total Daily Mask Use and Medical Waste Produced in India, China, Indonesia and South Korea

Country	Population	Total Daily Mask Use (piece)
India	1,381,085,714	381,179,657
China	1,439,323,776	989,103,299
Indonesia	273,753,080	159,214,791
South Korea	51,272,891	14,561,501

\*Source: Sangkham (2020)

### Environmental Consequences of Mask and Sanitation Product Wastes

Water pollution, plastic pollution, and climate change are common environmental issues as the result of the rising usage of masks and sanitation products during the pandemic. Most of the face mask that are available for us to use contains non-degradable polypropylene and/or polyethylene, polyurethane, polystyrene, polycarbonate, polyacrylonitrile which are microplastics that heavily pollutes the environment (Selvaranjan et al, 2021). Excessive use of disinfectants could also potentially threat living being and ecosystems (Dhama et al, 2021). For instance, direct contact of strong disinfectant may cause irritation and irreversible damage to skin and cornea. Environmental consequences of mask and sanitation waste products during the pandemic is listed in Table 8.2.

Table 8.2. Environmental Consequences of Mask and Sanitation Product Wastes

Components of Waste	Environmental Consequences
	Masks
Polypropylene and polyurethane <i>Toxic microplastic fibers</i>	<ul style="list-style-type: none"><li>- Enter food chain via ingestion and cause bioaccumulation of toxins.</li><li>- Disturb the aquatic environment as they cause oxidative damage and delay the growth of marine fish. Disruptions can lead to further problems in the food web and fewer concentration levels of carbon dioxide, which are needed for aquatic plants to perform photosynthesis and release oxygen.</li></ul>



Strings attached to masks	<ul style="list-style-type: none"> <li>- Tangling animals such as birds and disrupting their lives.</li> <li>- When ingested, blocking digestive tract in animals and prevent them from being able to digest food or perform other involuntary functions.</li> </ul>
Infectious mask	<ul style="list-style-type: none"> <li>- Improper disposal of facemask could act as a medium for further outbreak of COVID-19 as particles tend to proliferate microbes and disseminate food chain or infecting through direct contact.</li> </ul>
<b>Sanitation Products</b>	
VOC (Volatile Organic Compounds) <i>Gasses released from products</i>	<ul style="list-style-type: none"> <li>- Can potentially react with other gases like NO<sub>x</sub> and CO yielding O<sub>3</sub> (Ozone) which in ground level could interfere with photosynthesis, affect vegetation, and change the climate due to sunlight being more absorbed in ground level.</li> </ul>
Nitrogen or phosphorous-contained products (in soaps)	<ul style="list-style-type: none"> <li>- While it could encourage the growth of plants, increased concentrations can lead to algal blooms, which lower the water quality, disturb the food web, and decrease the oxygen levels that plants and fish needs to live.</li> </ul>
QUAT (Quaternary Ammonium Compounds)	<ul style="list-style-type: none"> <li>- Tends to repel water so they can "reduce the bioavailability and inhibit biodegradation, which are crucial to aquatic lives.</li> </ul>
Sodium Hypochlorite (NaOCl)	<ul style="list-style-type: none"> <li>- Can be extremely toxic to plant and animal life; potentially fatal. When plants absorb nutrients, they can also absorb leaked sodium hypochlorite in the process and die.</li> </ul>
Chlorine	<ul style="list-style-type: none"> <li>- Could produce disinfectant by-product such as haloacetic acids and trihalomethanes, which are highly toxic to aquatic flora and fauna</li> <li>- May react with organic matter in wastewater producing organic chlorine compounds that persist as environmental contaminants and pose a considerable risk to aquatic ecosystems</li> </ul>

*\*Source: Li et al., 2021; Selvaranjan,et al., 2021; Dhama et al, 2021*



**Figure 8.1. Mask waste entangling birds**  
*\*Source: Selvaranjan et al., 2021*





Figure 8.2. Mask waste polluting the ocean and entangling sea animals  
\*Source: Selvaranjan et al., 2021

## Suggestion

Table 8.1. suggests that countries that do not prioritize sanitation and proper waste management (ex: India) produce more medical waste per day. As pandemic wastes such as mask, sanitation products and general medical wastes contain harmful contaminants and toxic components, the excessive amount of these waste, when released to the environment with poor waste management can lead to extensive environmental problems, and even effect human life. Thus, we underline the significant importance of pandemic waste management being embedded in countries/government regulation to mitigate additional environmental damages related to the pandemic. Some immediate action that we also recommended to minimize some of the deleterious effects and improve environmental condition during this pandemic are:

- Cut the strings off the masks when you throw them away to avoid animals from getting tangled.
- Using eco-friendly masks. Masks from VIDA and Ecomask allow buyers to send their used masks back to the brand to be decontaminated and recycled.
- Using eco-friendly sanitation products wisely and not too excessive. Using hydrogen peroxide for bleach instead of sodium hypochlorite can reduce water pollution because they are bio-degradable and less toxic than sodium hypochlorite.
- Avoid excessive and unnecessary use of sanitation products to prevent environmental damage from chemicals.

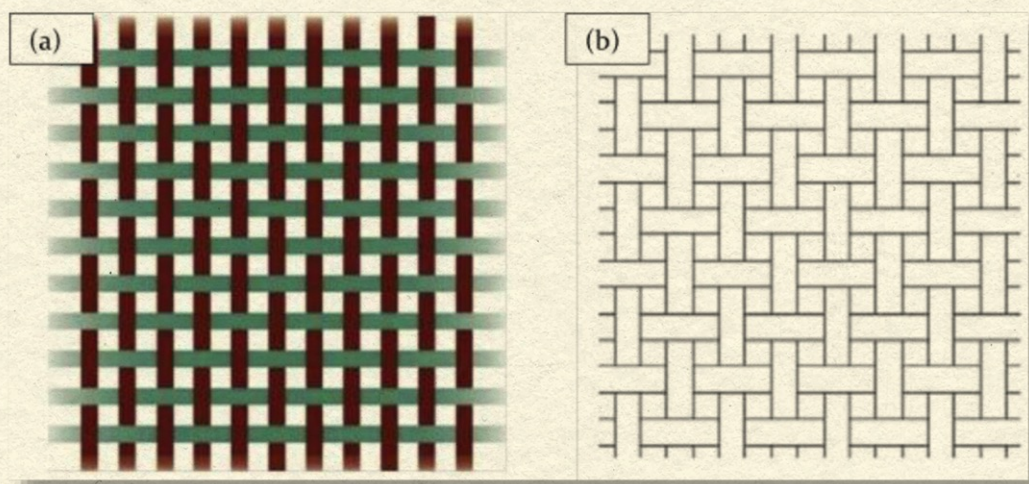


Figure 8.3. Woven technology in: (a) surgical mask; and (b) plant fibre  
\*Source: Selvaranjan et al., 2021



## References

### Intorduction

- Centers for Disease Control and Prevention (CDC). (2021). *How COVID-19 spreads*. Centers for Disease Control and Prevention. Retrieved February 5, 2022 from <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html>
- ICM Anaesthesia COVID-19. (n.d.). *Background to coronavirus*. ICM Anaesthesia COVID-19. Retrieved February 5, 2022 from <https://icmanaesthesiacovid-19.org/background>
- Otter, J.A., Donskey, C., Yezli, S., Douthwaite, S., Goldenberg, S.D., & Weber, D.J. (2015). Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. *The Journal of Hospital Infection*, 92(3), 235-250. <https://doi.org/10.1016/j.jhin.2015.08.027>
- Wellcome. (n.d). *What are mutations, variants, and strains?* Wellcome.com Retrieved February 5, 2022 from <https://wellcome.org/news/what-variant-expert-explains>
- World Health Organization (WHO). (n.d.). *Tracking SARS-CoV-2 variants*. World Health Organization. Retrieved February 5, 2022 <https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/>
- World Health Organization (WHO). 2020. *How to protect yourself from COVID-19*. World Health Organization. [https://cdn.who.int/media/images/default-source/health-topics/coronavirus/myth-busters/infographic-covid-19-transmission-and-protections-final2.jpg?sfvrsn=7fc5264a\\_2](https://cdn.who.int/media/images/default-source/health-topics/coronavirus/myth-busters/infographic-covid-19-transmission-and-protections-final2.jpg?sfvrsn=7fc5264a_2)
- Worldometer. (n.d.). *COVID-19 coronavirus pandemic*. Worldometer. Retrieved March 28, 2022, from <https://www.worldometers.info/coronavirus/>

### How does SARS-CoV-2 affect our body and how different is the omicron variant affecting our body compared to the original virus?

- Centers for Disease Control and Prevention (CDC). (2022). *Omicron variant: What you need to know*. Centers for Disease Control and Prevention. <https://www.cdc.gov/coronavirus/2019-ncov/variants/omicron-variant.html>
- Chen, J., Wang, R., Wang, M., & Wei, G.W. (2020). Mutations strengthened SARS-CoV--2 infectivity. *Journal of molecular biology*, 432(19), 5212–5226. <https://doi.org/10.1016/j.jmb.2020.07.009>
- Kumar, A., Narayan, R.K., Prasoon, P., Kumari, C., Kaur, G., Kumar, S., Kulandhasamy, M., Sesham, K., Pareek, V., Faiq, M.A., Pandey, S.N., Singh, H.N., Kant, K., Shekhawat, P.S., Raza, K., & Kumar, S. (2021). COVID-19 mechanisms in the human body—what we know so far. *Front. Immunol*, 12. <https://doi.org/10.3389/fimmu.2021.693938>
- Mandavilli, A. (2020, March 17). How long will coronavirus live on surfaces or in the air around you? *The New York Times*. <https://www.nytimes.com/2020/03/17/health/coronavirus-surfaces-aerosols.html>



- Mannar, D., Saville, J.W., Srivastava, S.S., Berezuk, A.M., Tuttle, K.S., Marquez, A.C., Sekirov, I., & Subramaniam, S. (2022). *Science*, 375(6582), 760-764. <https://doi.org/10.1126/science.abn7760>
- National Jewish Health. (2020). *How a Virus Infects the Body*. National Jewish Health. <https://www.nationaljewish.org/patients-visitors/patient-info/important-updates/coronavirus-information-and-resources/about-coronavirus-covid-19/related-articles/how-a-virus-infects-the-body>
- Scripps Research. (2020). *How does the novel coronavirus infect a cell?* Scripps Research <https://www.scripps.edu/covid-19/science-simplified/how-the-novel-coronavirus-infects-a-cell/>
- Scudellari, M. (2021). How the coronavirus infects cells — and why Delta is so dangerous. *Nature*, 595, 640-644. Retrieved from <https://www.nature.com/articles/d41586-021-02039-y>
- Thirukrishna, J.T., Krishna, S., Shashank, P., Srikanth, S., & Raghu, V. (2022). Survey on Diagnosing CORONA VIRUS from Radiography Chest X-ray Images Using Convolutional Neural Networks. *Wireless Personal Communications*, 124(3), 2261–2270. <https://doi.org/10.1007/s11277-022-09463-x>
- Trypsteen, W., Van Cleemput, J., Snippenberg, Wv., Gerlo, S., & Vandekerckhove, Linos. (2020). On the whereabouts of SARS-CoV-2 in the human body: A systematic review. *PLoS Pathog*, 16(10), e1009037. <https://doi.org/10.1371/journal.ppat.1009037>
- United Nation Children's Fund (Unicef). (2022). *What we know about the Omicron variant*. United Nation Children's Fund. <https://www.unicef.org/turkiye/en/stories/what-we-know-about-omicron-variant>
- United Nation Children's Fund (Unidef). (2021). *What you need to know about the Delta variant*. United Nation Children's Fund. <https://www.unicef.org/coronavirus/what-you-need-know-about-delta-variant>
- Wadman, M., Couzin-Frankel, J., Kaiser, J., & Maticic, C., (2020). A rampage through the body. *Science*, 368(6489). <https://doi.org/10.1126/science.368.6489.356>
- How does the vaccine regulation effect the spread and deaths of COVID-19 in South Korea?**
- Cao, W., Chen, C., Li, M., Nie, R., Lu, Q., Song, D., Li, S., Yang, T., Liu, Y., Du, B. & Wang X. (2021). Important factors affecting COVID-19 transmission and fatality in metropolises. *Public Health*, 190, e21–e23. <https://doi.org/10.1016/j.puhe.2020.11.008>
- Falahi, S. & Kenarkoohi, A. (2021). Host factors and vaccine efficacy: Implications for COVID-19 vaccines. *Journal of Medical Virology*, 94(4), 1330-1335. <https://doi.org/10.1002/jmv.27485>
- Lee, H., Noh, E. B., Park, S. J., Nam, H. K., Lee, T. H., Lee, G. R., & Nam, E. W. (2021). COVID-19 Vaccine Perception in South Korea: Web Crawling Approach. *JMIR public health and surveillance*, 7(9), e31409. <https://doi.org/10.2196/31409>



- Mathieu, E. & Roser, M. (2021, November 23). *How do death rates from COVID-19 differ between people who are vaccinated and those who are not?*. Retrieved from <https://ourworldindata.org/covid-deaths-by-vaccination>
- Our World in Data. (n.d.a). *Coronavirus (COVID-19) vaccination*. Our World in Data. Retrieved February 5, 2022 from <https://ourworldindata.org/covid-vaccinations>
- Our World in Data. (n.d.b). *Daily new confirmed COVID-19 cases and deaths, South Korea*. Our World in Data. Retrieved February 5, 2022 <https://ourworldindata.org/grapher/daily-covid-cases-deaths-7-day-ra?country=~KOR>
- Roy, S. & Ghosh, P. (2020). Factors affecting COVID-19 infected and death rates inform lockdown-related policymaking. *PLOS ONE*, 15(10), e0241165. <https://doi.org/10.1371/journal.pone.0241165>
- Speiser, D. E. & Bachmann, M. F. (2020). COVID-19: Mechanisms of vaccination and immunity. *Vaccines*, 8(3), 404. <https://doi.org/10.3390/vaccines8030404>
- Velasco, M. J., Tseng, W. & Chang, C. (2021). Factors affecting the cases and deaths of COVID-19 victims. *Int. J. Environ. Res. Public Health*, 8(2), 674. <https://doi.org/10.3390/ijerph18020674>

### How does COVID-19 patient's chest-CT result differ from the healthy ones?

- Dixon, A. (n.d.). *Normal CT chest*. Radiopaedia. <https://radiopaedia.org/cases/normal-ct-chest>
- Kwee, T.C. & Kwee, R.M. (2021). Chest CT in COVID-19: What the radiologist needs to know. *Radiographics*, 40(7), . <https://doi.org/10.1148/rg.2020200159>
- Mayo Clinic. (2022). *CT scan*. Mayo Clinic. <https://www.mayoclinic.org/tests-procedures/ct-scan/about/pac-20393675>
- Pontone, G., Scafuri, S., Mancini, M. E., Agalbato, C., Guglielmo, M., Baggiano, A., Muscogiuri, G., Fusini, L., Andreini, D., Mushtaq, S., Conte, E., Annoni, A., Formenti, A., Gennari, A. G., Guaricci, A. I., Rabbat, M. R., Pompilio, G., Pepi, M., & Rossi, A. (2021). Role of computed tomography in COVID-19. *Journal of cardiovascular computed tomography*, 15(1), 27–36. <https://doi.org/10.1016/j.jcct.2020.08.013>
- Smith, D. (n.d.). *CT: Day 13 – Performed to assess degree of lung injury*. Radiopaedia. <https://radiopaedia.org/play/33005/entry/573060/case/75249/studies/86359?lang=us>

### How effective are lung transplants for COVID-19 patients?

- Bharat, A., Machuca, T.N., Querrey, M., Kurihara, C., Garza-Castillon, R., Jr., Kim, S., Manerikar, A., Pelaez, A., Pipkin, M., Shahmohammadi, A., Rackauskas, M., Rao, S., Balakrishnan, K.R., Jindal, A., Schaheen, L., Hashimi, S., Buddhdev, B., Arjuna, A., Rosso, L., Palleschi, A., Lang, C., Jaksch, P., Budinger, G.R.S., Nosotti, M., & Hoetzenecker, K. (2021). Early outcomes after lung transplantation for severe COVID-19: a series of the first consecutive cases from four countries. *The Lancet*, 9(5), 487-497. [https://doi.org/10.1016/S2213-2600\(21\)00077-1](https://doi.org/10.1016/S2213-2600(21)00077-1)



- King, C.S., Mannem, H., Kukreja, J., Aryal, S., Tang, D., Singer, J.P., Bharat, A., Behr, J., & Nathan, S.D. (2021). Lung transplantation for patients with COVID-19. *Chest Journal*, 161(1), 169-178. <https://doi.org/10.1016/j.chest.2021.08.041>
- Mayo Clinic. (2022). *Lung Transplant*. Mayo Clinic. <https://www.mayoclinic.org/tests-procedures/lung-transplant/about/pac-20384754>

### What are the medicines uses for COVID-19 patient?

- Auwaerter, P. and Casadevall, A. (2022, February 17). *Is COVID-19 Treatable?* The Johns Hopkins University. Retrieved May 5, 2020 from <https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/coronavirus-treatment-whats-in-development?amp=true>
- Centers for Disease Control and Prevention [CDC]. (2022, March 22). *Symptoms of COVID-19*. Centers for Disease Control and Prevention. Retrieved May 5, 2020 <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>
- Cleveland Clinic. (2016, December 7). *Is Your Immune System Unhealthy? Why Things Can Go Wrong?* Cleveland Clinic. Retrieved May 5, 2020 <https://health.clevelandclinic.org/can-immune-system-go-haywire-falter/>
- Harvard Medical School. (2022, April 12). *Treatments for COVID-19*. The President and Fellows of Harvard College. Retrieved May 5, 2020 from <https://www.health.harvard.edu/diseases-and-conditions/treatments-for-covid-19>
- Indari O., Jakhmola, S., Manivannan, E., & Jha, H.C. (2021). An update on antiviral therapy against SARS-CoV-2: How far have we come? *Front. Pharmacol.*, 12. <https://doi.org/10.3389/fphar.2021.632677>
- Mayo Clinic. (2021, April 28). *Convalescent plasma therapy*. Mayo Foundation for Medical Education and Research. Retrieved May 5, 2020 <https://www.mayoclinic.org/tests-procedures/convalescent-plasma-therapy/about/pac-20486440>
- Murdock, J. (2022, May 6). *The Latest Updates on COVID-19 Treatments and Medications in the Pipeline*. GoodRx, Inc. Retrieved May 5, 2020 from <https://www.goodrx.com/conditions/covid-19/coronavirus-treatments-on-the-way>
- National Institutes of Health [NIH]. (n.d.). *Calming an Overactive Immune System*. National Institutes of Health. <https://covid19.nih.gov/news-and-stories/activ-1-im>
- Puckey, M. (2022, May 11). *COVID-19: Prevention & investigational treatments*. Drugs.com. Retrieved May 5, 2020 from <https://www.drugs.com/condition/covid-19.html>
- Sanders, J.M., Monogue, M.L., & Jodlowski, T.Z. (2020). Pharmacologic treatments for coronavirus disease 2019 (COVID-19). *JAMA*, 323(18), 1824-1836. <https://doi.org/10.1001/jama.2020.6019>
- Zimmer, C. Wu, K.J., Corum, J., & Kristoffersen, M. (2022, April 5). *Coronavirus Drug and Treatment Tracker*. *The New York Times*. Retrieved May 5, 2020 from <https://www.nytimes.com/interactive/2020/science/coronavirus-drugs-treatments.html>



## How do supplements help our body fight against COVID-19?

- DeSoto, L. (2022, February 2). Do supplements really benefit the immune system? *Medical News Today*. <https://www.medicalnewstoday.com/articles/do-supplements-really-benefit-the-immune-system>
- Harvard T. H. Chan School of Public Health (HSPH). (n.d.). *Nutrition and Immunity*. Harvard T. H. Chan School of Public Health. <https://www.hsph.harvard.edu/nutritionsource/nutrition-and-immunity/#:~:text=%5B8%5D%20These%20nutrients%20help%20the,immune%20cells%2C%20and%20producing%20antibodies>
- Hasan, S., Egbuna, C., Tijjani, H., Ifemeje, J.C., Olisah, M.C., Patrick-Iwuanyanwu, K.C., Onyeike, P.C., & Ephraim-Emmanuel, B.C. (2020). Dietary supplements: Types, health, benefits, industry, and regulation. *Functional Foods and Nutraceuticals* (pp. 23-38). [https://doi.org/10.1007/978-3-030-42319-3\\_3](https://doi.org/10.1007/978-3-030-42319-3_3)
- Macmillan, C. (2020, June 11). *Vitamin D Deficiency and COVID-19: Is There a Connection?* Yale Medicine. <https://www.yalemedicine.org/news/vitamin-d-covid-19>
- Marshall, W.F. (2021, February 10). *Can taking a vitamin D supplement prevent infection with the virus that causes the coronavirus disease 2019 (COVID-19)?* Mayo Clinic. <https://www.mayoclinic.org/diseases-conditions/coronavirus/expert-answers/coronavirus-and-vitamin-d/faq-20493088>
- Mayo Clinic. (2020, November 17). *Zinc: Overview*. Mayo Clinic. <https://www.mayoclinic.org/drugs-supplements-zinc/art-20366112#:~:text=Zinc%2C%20a%20nutrient%20found%20throughout,meat%20and%20fortified%20breakfast%20cereals>
- National Institutes of Health. (2020). *Dietary Supplements in the Time of COVID-19*. National Institutes of Health. <https://ods.od.nih.gov/factsheets/COVID19-HealthProfessional/>
- National Institutes of Health. (2022). *Dietary Supplements: What You Need to Know*. National Institutes of Health. <https://ods.od.nih.gov/factsheets/WYNTK-Consumer/>
- Nurhayati-Wolff, H. (2020, February 15). *Share of people whose frequency of taking dietary supplements increased after the outbreak of the coronavirus (COVID-19) pandemic in Indonesia as of July 2020, by gender*. Statista. <https://www.statista.com/statistics/1183078/indonesia-covid-19-impact-on-dietary-supplement-intake-by-gender/>
- Speakman L.L., Michienzi, S.M., & Badowski, M.E. (2020). Vitamins, supplements and COVID-19: a review of currently available evidence. *Drugs in context*, 10, 2021-6-2. <https://doi.org/10.7573/dic.2021-6-2>



What are the effects of massive use of mask and sanitation products during the COVID-19 pandemic to the environment?

- Dhama, K., Patel, S.K., Kumar, R., Masand, R., Rana, J., Yattoo, M.I., Tiwari, R., Sharun, K., Mohapatra, R.K., Natesan, S., Dhawan, M., Ahmad, T., Emran, T.B., Malik, Y, S., & Harapan, H. (2021). The role of disinfectants and sanitizers during COVID-19 pandemic: advantages and deleterious effects on humans and the environment. *Environ Sci Pollut Res* (28), 34211-34228. <https://doi.org/10.1007/s11356-021-14429-w>
- Li, Y., Sun, Y., Li, J., Tang, R., Miu, Y., & Ma, X. (2021). Research on the influence of microplastics on marine life. *IOP Conf. Ser.: Earth Environ. Sci*, 631, 012006. <http://dx.doi.org/10.1088/1755-1315/631/1/012006>
- Malin, Z. (2021, April 22). How to reduce face mask pollution, according to experts. *NBC News*. <https://www.nbcnews.com/select/shopping/eco-friendly-face-mask-ncna1264810>
- Sangkham, S. (2020). Face mask and medical waste disposal during the novel COVID-19 pandemic in Asia. *Case Studies in Chemical and Environmental Engineering* 2, 100052. <https://doi.org/10.1016/j.cscee.2020.100052>
- Selvaranjan, K., Navaratnam, S., Rajeev, P., & Ravintherakumaran, N. (2021). Environmental challenges induced by extensive use of face masks during COVID-19: A review and potential solutions. *Environmental Challenges*, 3, 100039. <https://doi.org/10.1016/j.envc.2021.100039>



## Postface

Findings reported in this book answer some of the concerning issues related to the pandemic in the early of 2022, when the sub-topic was being decided. Those includes variants of SARS-CoV-2, vaccine regulations significance to the pandemic, COVID-19 diagnosis tools, lung transplant efficiency, medicine and supplements uses during the pandemic, and pandemic related impact on the environment. We acknowledge that COVID-19 related research has developed rapidly since the beginning of the pandemic following new findings and new decisions to counteract the negative effects of the virus in humans.

Recently, as cases went down throughout the world, regulations for the pandemic are getting more relaxed in countries. Booster were applied as new variants are occurring or to simply maintain immunity against the virus. At the same time, vaccination seemed to degrade the effectivity of natural immunity, but are still recommended for individuals with compromised immunity. Now, the occurrence of Omicron sub-variants also raises the concerns of reinfections.

Researches on medicines and supplements for COVID-19 however, are still perceive to be significant and relevant to this pandemic, especially to properly boost immunity and to find/develop medicines that are effective to directly disarmed the virus and counteract its negative effects in human body. As lung damage caused by COVID-19 is irreversible, lung transplant so far has been the leading solution to restore this damage and CT-scan will still be a useful diagnostic tool with various purposes for COVID-19 patients administered in hospitals.

Even though restriction for the COVID-19 pandemic seems to be more relaxed in many countries, mask and sanitary products is still widely used throughout the world. The use of mask and sanitary products even develop to become new customs in some societies. Solutions are still needed to widely regulate the use and disposal of mask and sanitation products, as well as to properly manage the pandemic waste.

Even though it might get less relevant as time goes by, we believe that the findings in these reports are significant to understand general things such as: the mechanism of the virus that we are dealing with in this COVID-19 pandemic; why and how vaccine regulations should be applied in society based on how big the virus' threat is but also by how our body works, the body' natural ability as well as its limitations; how far has the medical field advanced and has helped in this pandemic, and what are the future opportunities; lastly, why is it important to be more cautious about our compulsion/habit in using mask and sanitation products during this pandemic, and how we can reduce its negative effects to our environment.

We are glad for the opportunity to study and discuss about health and environmental issues during this pandemic and to also report what we are able to learn and come to understand. We look forward to see what science could offer to the world in giving solutions to issues/problems arising from this pandemic. We hope that together, we could finally overcome this devastating situation with a positive outcome.

June, 2022  
Editor





"But those who hope in the Lord will renew their strength.  
They will soar on wings like eagles, they will run and not grow weary,  
they will walk and not be faint."

**(Isaiah 40:31)**











